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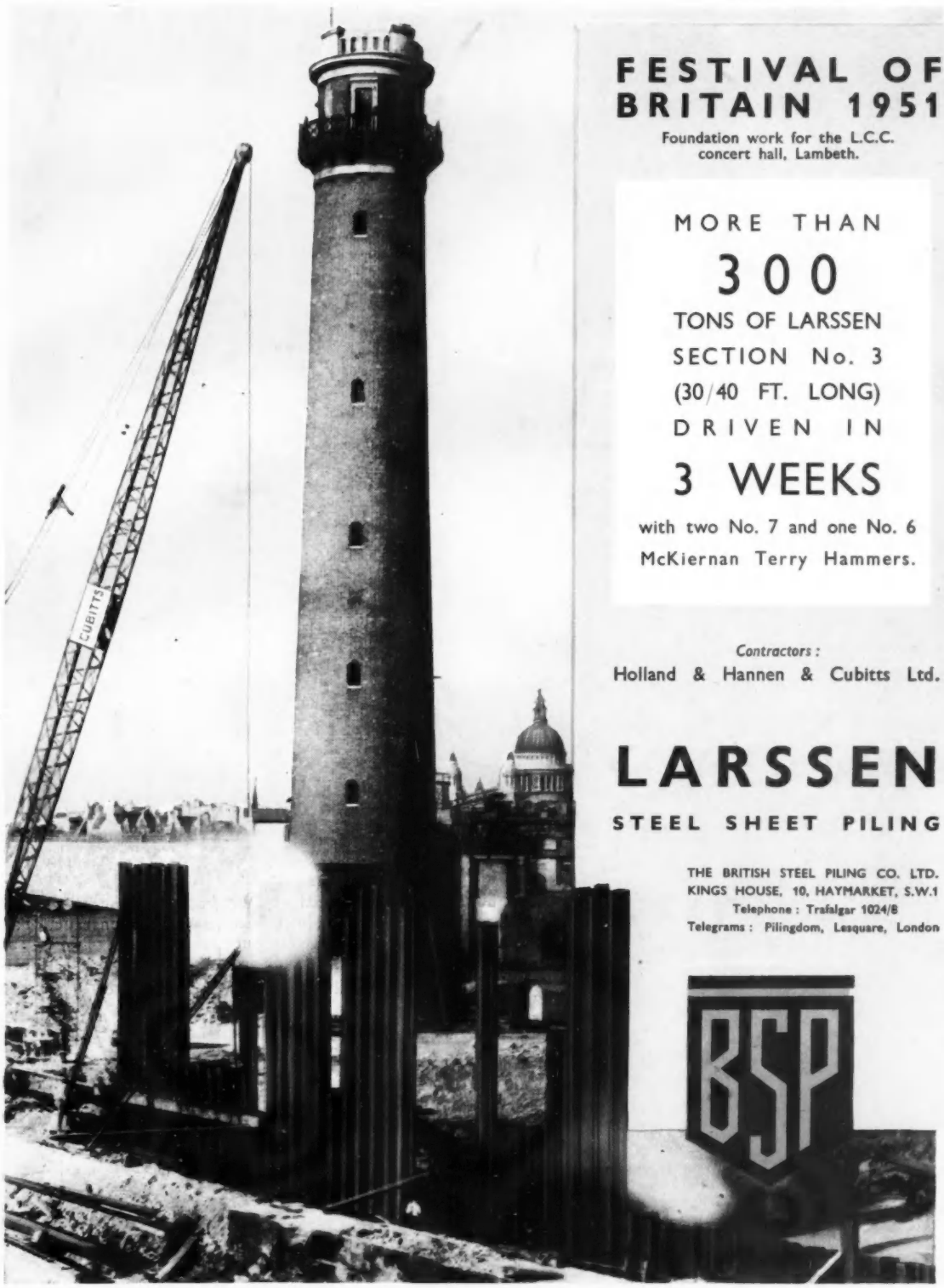

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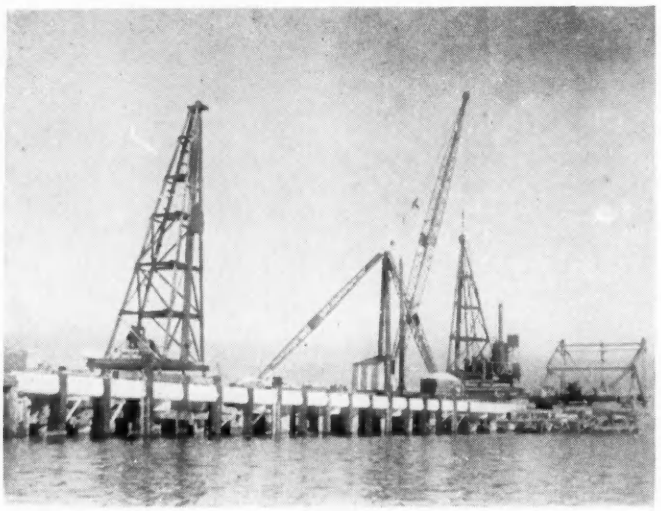

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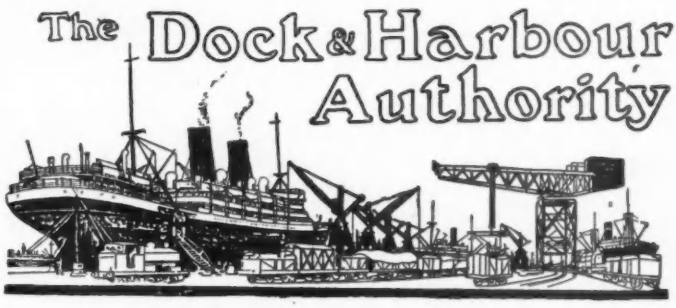

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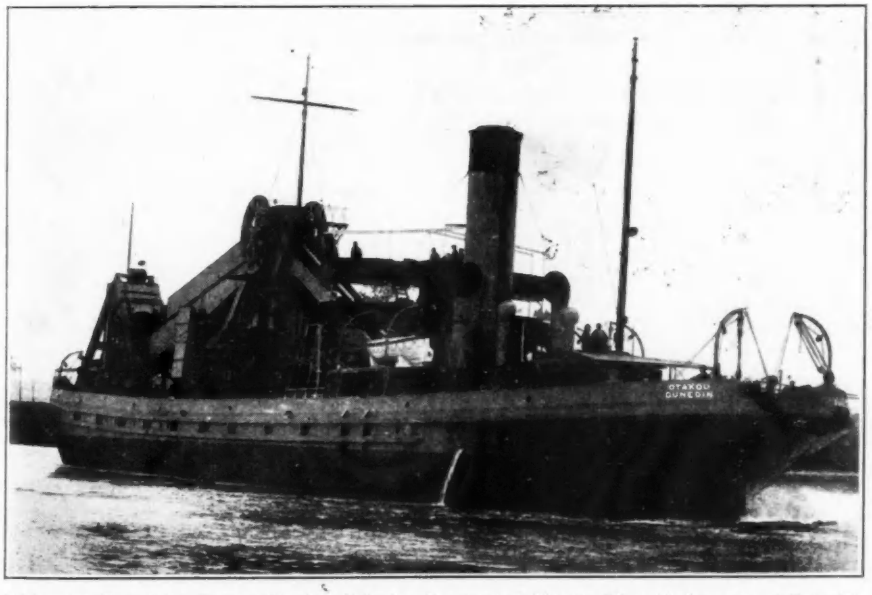

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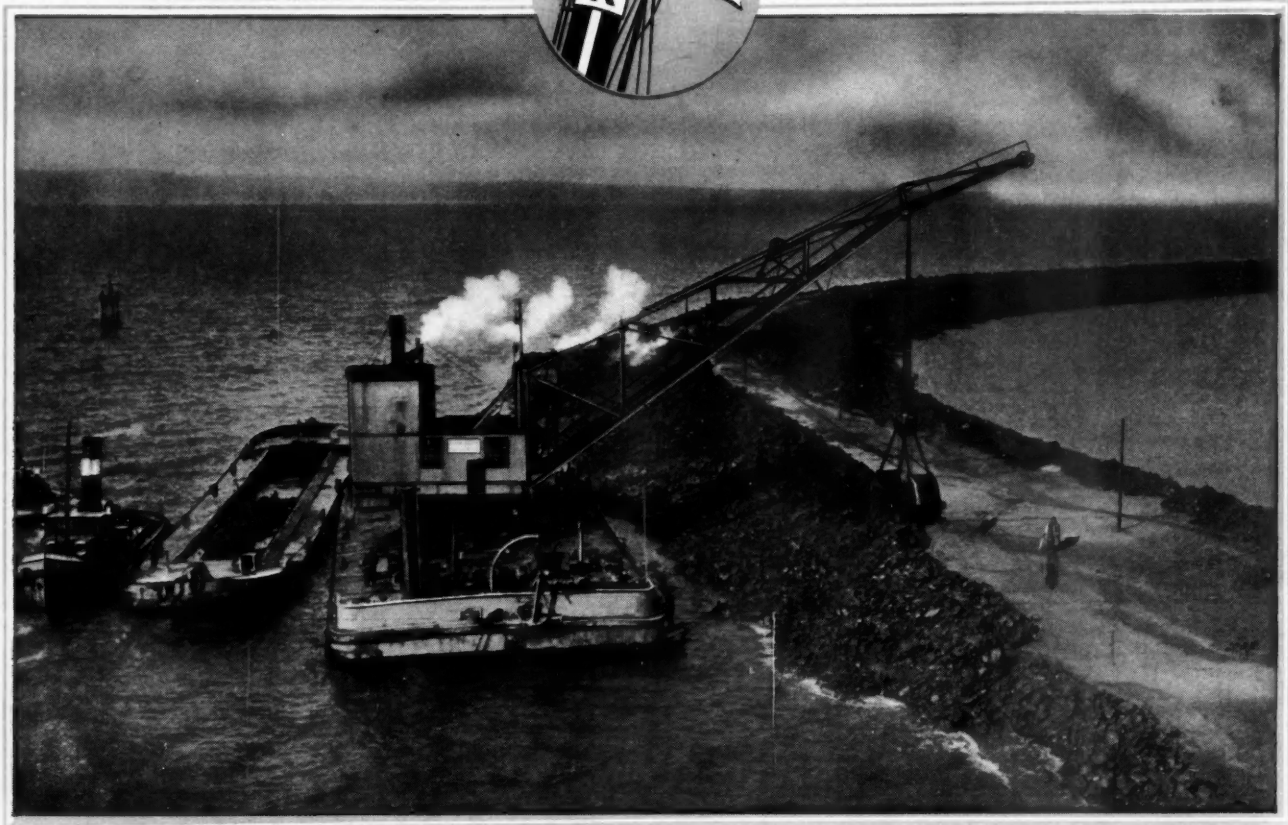

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The Dock and Harbour Authority

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Editorial Comments

THE PORT OF CALCUTTA.

Calcutta, one of the principal ports on the east coast of the Dominion of India, with a population of nearly 4¼ million, is situated in the province of Bengal, on the east bank of the River Hooghly, at a distance of about 80 miles from the sea. The port is one of the busiest in the world and the banks of the Hooghly rival those of the Thames and the Port of London in their show of shipping. Moreover, Calcutta, like London, is predominantly a terminal port.

The tidal and fluvial conditions prevailing in the River Hooghly are irregular and conflicting, being greatly influenced by the prevailing winds at various times of the year, together with the alternating wet and dry seasons. Considerable dredging is necessary to maintain shipping channels, and navigation of the river is most difficult, due to the tortuous channels which wind through numerous sand banks which frequently change their position.

Due to the difficulties of the channel, the pilotage service is important, and the pilots are necessarily most expert. Ships up to 15,000 tons can ascend to the port, but the maximum draught of vessels is limited to 30-ft.

It will be remembered that in our issue of December, 1946, we published an account of the war time emergency organisation of the Port of Calcutta. We are now favoured with an article by Mr. R. M. H. Garvie, the Chief Engineer, in which he gives a highly informative description of the present conditions in the port, and interesting details of recent developments and of plans for the future.

The Port of Calcutta is well known in engineering circles as the site of that unique cantilever structure, the Howrah Bridge, completed in 1942, and many readers, particularly those concerned with dock engineering, will also be familiar with the construction difficulties and failures of the walls of the No. 1 Kidderpore Dock, which occurred during their erection in 1890, and which resulted later in the use of monolith construction for the new Kidderpore Lock in 1906, and for the dock wharves, graving dock and lock entrance of the King George Dock, constructed during the years 1920-1929.

Among the more recent developments at the port, it is interesting to observe the lay-out adopted for the new berths in No. 2 Dock, and more particularly the modern quay and shed construction in King George's Dock, embodying semi-portal cranes, wide quays, verandahs, and special arrangements for dealing with road and railway deliveries by means of island platforms, following principles adopted in some American ports. Mention should also be made of the new fully mechanical coal loading plant, now being erected to deal with the important coal exports which form a large part of the trade of the port.

It is proverbial that the East provides examples of extreme modernity and antiquity side by side, and apart from the bullocks harnessed to the crude carts which can be seen crossing the Howrah Bridge, in the docks we find many operations still carried out by that most primitive of means—hand labour. However, these cargo handling methods cannot be criticised in this instance, for the very good reasons given by Mr. Garvie. Moreover, where mechanisation is economic, and modernisation of equipment and other facilities is desirable, Calcutta must be regarded as one of the most up-to-date ports of the world.

We cannot conclude our observations without reference to the programme of future improvements of the port, which include two major schemes: the extension of King George's Dock to provide 30 additional ships' berths, together with a scheme of great complexity—a proposed ship canal. The latter is now being investigated by means of hydraulic models, satisfactory conclusions from which would go far towards eliminating the existing heavy expenditure on dredging, and the limitation on the size of ships which can be accommodated.

RADAR AND MARINE RADIO DEVELOPMENTS.

The invention and adaptation of radar and its auxiliary—short range radio telephony—to the needs of navigation is a study of considerable interest. In 1944, realising the value of the war time use of radar to ports and shipping, a Government Committee was set up to consider and make recommendations for the development of radar as an aid to navigation in coastal waters. Since then, manufacturers of equipment, together with the Ministry of Transport and other organisations such as the Radio Advisory Service established by the Chamber of Shipping and the Liverpool Steamship Owners' Association, have done much useful work. It was soon realised that the value of radar, both on ships and on shore, would be increased immeasurably if operators could talk to each other, and this has, of course, been accomplished by the use of the short range radio telephone, working in association with the radar installation.

We frequently hear of the equipment of ocean going vessels with radar, and of the installation of shore based radar apparatus at many ports in different parts of the world, and more recently of the use of radio telephony as a means of communication in ports. For example, in our issue for last March, is recorded the use of V.H.F. radio telephones to control a fleet of dredgers in the Ribble, and in the same issue, reference is made to a shore based radar and radio telephone inter-communication system at the Port of Long Beach, California, U.S.A. Also, on another page in the present number, mention is made of the equipment provided on harbour service craft at the Port of Calcutta.

We are also publishing, on page 86 of this issue, a short article upon a new marine radio system which has recently been installed at Liverpool by the Mersey Docks and Harbour Board. In an estuary approach to a port such as Liverpool, the value of the services rendered by the new installation of radar and telephony, with its portable transmitting and receiving sets, will be readily appreciated.

In large ports of similar geography, the ideal of having all craft of any size fitted with a suitable radio telephone will probably take years to achieve, involving as it does problems of

Editorial Comments—continued

standardization and international agreement, but the Port of Liverpool has established in this country what may well be a lead in this direction.

Now that the first steps towards communication with a limited number of vessels have been taken, we can expect an extension of the system to other ports and harbours, and the many varieties of craft working in isolated areas of them.

THE SOCIAL PROBLEM OF THE NARROW CANALS.

On a number of occasions during the past year or two we have referred to social problems concerning the men and their families who work on the canals and inland waterways of this country, and more especially, in our issue for June 1949, we referred to the necessity for improving the social amenities for long distance canal boatmen and the opportunities for the education of their children.

It is therefore encouraging to learn that within the last few weeks, two meetings were held between an official of the Transport and General Workers' Union and some representative crews and families of narrow canal boats, with a view to improving their working and living conditions. The first meeting was held at Sutton's Stop Lock, Longford, near Coventry, and the second at the Bull's Bridge Depot, near Southall, London. The subjects debated covered a wide field and ranged from the nomination of Union representatives, the provision of baths and washing facilities at either end of the usual journeys, to the matter of water taps at various recognised stopping places.

The question of the education of the children was also considered, and tentative recommendations were agreed for the provision of day schools at Bull's Bridge, and in the Warwickshire coal fields, which are regarded as strategic points, visited by more narrow boats than any other calling points in the south-east region. The hostel, which is being provided for children at Birmingham, was also discussed and doubts were expressed upon whether parents would agree to being separated from their children with only rare opportunities to visit them.

In our view, any policy which involves children under the age of ten being parted from their parents should not be tolerated, and the needs of the younger children's education can only be met by day schools run on more or less Montissori methods. On the other hand, the present situation, under which these children receive virtually no school instruction, is clearly equally to be deplored. This problem cannot be treated as distinct from the economic aspects of narrow boat operation, which were so clearly expounded by Brig.-General Sir Osborne Mance in the paper presented to the Institute of Transport on 6th December, 1949, and reported upon in these columns in our January, 1950, issue.

We understand that recommendations are now being prepared by the Union for submission to the National Joint Committee for the Waterways Industry, and ultimately, it is hoped, for adoption by the Docks and Inland Waterways Executive. We hope these negotiations will soon show some tangible results, and further developments will be watched with interest.

MECHANISATION IN UNITED KINGDOM PORTS.

As stated in our last issue, we are publishing in this number the salient points of the Report of the Working Party, which, in March, 1948, was appointed "to make a comprehensive review of increased mechanisation in the ports of the United Kingdom". The Report is both cogent and timely and should be carefully studied by employers and union officials, and indeed by all those whose livelihood is concerned with the handling of cargoes at ports. It gives a clear review of present conditions and makes some valuable recommendations for the future.

The need for mechanisation at docks has been repeatedly emphasised in this Journal, and the conclusions of the Working Party show clearly that there is a wide field for the increased improvement of mechanical aids in the port industry, but that no large scale development in the use of mechanical handling equipment is likely to take place at our ports unless and until the problem of the efficient and economic use of mechanical equipment has been settled on a national basis by all concerned with ports and shipping.

This, surely, is the crux of the matter, and until the old suspicions and prejudices among the dockers are eliminated there is little hope that real progress will be made. To remove prejudices and restrictive practices the unions will have to play a predominant part, and however ready employers and well-wishers may be with their advice (some of which is not always helpful or constructive), it is eventually the union official in his day-to-day contact with the men who has the exceedingly difficult task of bringing about a change in outlook and an appreciation of the advantages of mechanisation.

In our view, the psychological difficulties are not sufficiently appreciated. The task of reasoning with large bodies of men, among whom there are many subversive and irresponsible elements, who create unrest and are largely responsible for many of the unofficial strikes which have been an unfortunate feature at the docks during the past few years, requires tact and courage of no mean order. As Sir John Anderson intimated, when speaking at the Mechanical Handling Exhibition held in London early last month, union leaders fully appreciate the prevailing position, but have the difficult task of "getting it across to the rank and file". He also emphasised the need for patience, in view of the past long history of the docks with many traditions which, at the present time, are at variance with modern needs. "The process of breaking tradition down," he pointed out, "is bound to be slow."

INTERNATIONAL LIGHTHOUSE CONFERENCE.

British lighthouse technicians will take an important part in the five-day International Lighthouse Conference which is being held in Paris from 3rd-7th July. Normally, these Conferences are held every four years, but this will be the first since 1937.

Delegates from marine authorities all over the world will attend to discuss the efficiency of navigational warnings on dangerous coasts and sand banks, and technical papers will be submitted by engineers from England, United States of America, France, Sweden and Finland. It is hoped that the published British Standard Formula for Lighthouse Beams will be discussed, and that in due course a similar standard will be applied to fog-signals.

It is interesting to observe that next year it will be one hundred years since the first lighthouse optic was exhibited at the Great Exhibition of 1851, since when notable advances have been made in this field of engineering. Many famous names are linked with this century of progress; they include Michael Faraday, who, as an official of Trinity House, worked in close co-operation with Sir James Timmins Chance (the pioneer of British lighthouses), and Dr. John Hopkinson, the eminent electrical engineer who invented the group flashing system, which gave a much wider range of characteristic and enabled one lighthouse to be readily identified from another.

THE KENNET AND AVON CANAL.

The notice issued by the S.W. Divisional Waterways Officer of the Docks & Inland Waterways Executive, announcing the closure of about 8 miles of the River Kennet section of the Kennet & Avon Canal, has excited adverse criticism in some contemporary publications.

On enquiry, the D. & I.W.E. inform us that this order was issued owing to the poor condition of the locks. As is well known, most of these locks are of a primitive type, with sloping grass banks in place of the usual brickwork, so that rehabilitation would involve great expense.

The Executive further inform us that, prior to this closure, certain investigations had been made to ascertain if there was justification for rehabilitation of this waterway. The result indicated that there are no prospects of a sufficiency of traffic to justify incurring the expenditure which would be needed to restore the waterway to a condition suitable for commercial navigation.

Unfortunately the Executive are unable to indicate when the closure notice will be withdrawn, but express the hope that at least some river sections will remain open for pleasure boating and some local commercial traffic.

The cost of reconstruction to enable the navigation to pass esturial craft throughout its length, which all authorities agree is an essential prerequisite to economic operation, would, in our opinion, be out of all proportion to the value of any traffic which might derive.

The Port of Calcutta

A Major Port of the Dominion of India

By R. M. H. GARVIE, B.Sc., M.I.C.E.
(Chief Engineer to the Calcutta Port Commissioners).

INTRODUCTION

IN his book, "British Shipping," Mr. R. H. Thornton has written ruefully—"the great ports of the world are mostly situated on wretched creeks and tidal estuaries, whose silting channels and shifting bars cost a fortune annually for every foot of depth maintained." This is unfortunately true of too many of the world's ports, but it should never be thought that the locations are the result of haphazard selection and lack of vision. A harbour must afford safety and shelter to shipping, conditions not normally met upon exposed coastlines, hence the site tends to be on a river or estuary. A second condition of considerable importance, especially in the past, is that at the chosen place the waterway should be narrow enough to be crossed by a bridge, floating or fixed. A third is that the water at the wharves themselves should be permanently deep enough to float ships. All these factors were probably in the mind of Job Charnock when he landed in 1690 on the bank of the Hooghly, where Calcutta, with its four millions or more of population, now sprawls over miles of territory.

The city and port are situated on the left bank of the river, about 80 miles from the sea, and the waterway as it passes through the urban area varies from 1,500 to 2,200-ft. in width. The maximum range of the tide at Calcutta is about 22-ft.

The main lines of the East Indian and Bengal Nagpur Railways systems terminate at Howrah Station, on the right bank, to which the only road access until recent years was by floating bridge. Just downstream of the bridge and station the eight Calcutta Jetties, built between 1868 and 1879, were most conveniently located close to the commercial heart of the city, but towards the end of the century it became clear that trade was developing far beyond their capacity. Kidderpore Dock No. 1, its basin and entrance two miles downstream, was opened in 1892 and provided 12 berths. These were designed to give a depth alongside of 26-ft., but as a consequence of wall movement which occurred after completion the water level was raised by 7-ft. to improve the stability, and the depth has thus been 33-ft. since the opening.

In the 1900's extensions were carried out southward to form Dock No. 2, and it eventually provided five general berths (Nos. 22-26) on the east side, and coal berths on the west side. Construction of four new riverside berths at Garden Reach was interrupted by the war in 1914, and they were not completed until 1924.

Meanwhile work had been started on the new basin which was subsequently named King George's Dock, and this was opened for use in December, 1928. This dock then consisted of four general berths, numbers 2, 3, 4 and A, and a laying-up berth, No. 1. B berth came into use shortly after for laying-up, and C berth was reserved for inland vessels.

Petroleum imports were handled at Budge Budge, twelve miles downstream from Kidderpore, and after a fire in 1903 the depot was entirely remodelled; five pontoon landing stages were installed, and the area zoned for the different purposes of storage in tins, or in bulk, or for workshops.

The facilities existing in the port about the year 1930 may be summarised as under:—

Calcutta Jetties	8 berths
Kidderpore Dock No. 1 ...	12 berths
No. 2 ...	5 berths, 8 coal berths and 3 laying up berths
Garden Reach Jetties	4 berths and 1 coal berth
King George's Dock	4 berths, 2 laying up berths and 1 inland berth
Budge Budge	5 oil berths

No mention has been made of buoy berths, as the use made of them varies greatly throughout the year, but at this period there were some 60 buoy moorings in the river where ships could be loaded or discharged by lighter.

The tides at Calcutta are influenced by the monsoon season freshets, and the highest levels are recorded in September. The daily tidal range is of the order of 12 to 14-ft. springs and 4 to 6-ft. at neaps, but mean tide level is about 5-ft. higher in September than in February. Bores of varying magnitude occur through the greater part of the year, the effect being most noticeable about March-April and September; the wave may be of the order of 6-ft. in height and in the Calcutta reach sweeps strongly up the right bank. Port Datum is an old dock sill, and related to this the most important levels are:—

Highest Ordinary High Water	22.5
Lowest Ordinary Low Water	2.5
Lowest High Water	9
General quay level, and of adjoining lands ...	24
Coping at entrances	26

The port is administered by a Board of Commissioners, and the Board was first constituted by an Act of 1870. Changes were made from time to time, and in 1921 Calcutta, with Bombay, Karachi, Madras and Rangoon, was declared to be a major port under the general control of the Central Government. The Chairman and Deputy Chairman are whole-time salaried officers, and the Commissioners are elected or act ex officio to represent the Railways, Customs, Mercantile Marine Department, the Calcutta Corporation, and the mercantile and shipping interests. Under the Administration the port is divided into departments—Accounts, Engineering, Deputy Conservator (including Harbour Master and River Surveyor), Traffic, Chief Mechanical Engineer, Stores, and Medical. The Commissioners' Consulting Engineers are Messrs. Rendel, Palmer & Tritton.

TRADE

Exact figures for corresponding periods are not readily available, but it is probably a correct statement that Calcutta handles about half the seaborne trade of India. In 1939-1940 Calcutta's tonnage was 9,965,911 out of an all-India total of 21,552,061, and to-day, the Pakistan figures for the ports of Karachi and Chittagong being excluded, the proportion must be greater.

In the year ending March, 1949, 1,214 sea-going vessels, having an aggregate gross tonnage of 7,385,320, entered the port. Country and inland craft are not included in these figures.

The following table shows the trade of the port in tons for the past three complete years:—

Year ending	Imports	Exports	Total
March, 1947 ...	2,039,451	4,398,614	6,438,065
March, 1948 ...	2,483,744	4,465,784	6,949,528
March, 1949 ...	3,264,321	4,898,746	8,163,067

At the time of writing the indications are that the tonnage for the current year, 1949-1950, will exceed the previous totals.

The principal commodities handled during the year 1948-1949 were as follows:—

Imports (tons)		Exports (tons)	
Cement	113,375	Coal	2,510,760
Grain	725,402	Bunkers	393,413
Lubricating Oils ...	107,220	Gunnies	1,020,076
Other Oils	72,201	Jute	205,664
Machinery	112,744	Tea	180,378
Petrol	540,423	Iron and Steel ...	89,553
Salt	498,494	Ores	88,895
Soda	125,230		
Non-ferrous metals ...	70,880		
Timber	76,332		

Of the total tonnage handled 71% passed over the quays and jetties.

Coal is handled entirely at special berths which are described below. Grain arrives both in bulk and bagged. Bulk grains are discharged entirely by manual labour, being bagged in the ship's hold and delivered to rail or road vehicles or into transit shed; dis-

The Port of Calcutta—continued

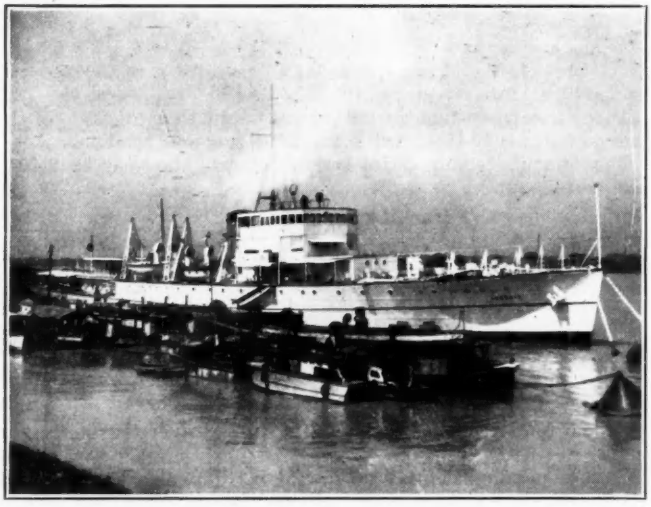
Looking along Berths Nos. 29-28-27, Kidderpore Docks, showing 30-ton and 6-ton yard cranes and war time T.G. type transit sheds.

charge by this method is of the order of 2,000 to 2,500 tons per day of two shifts. Salt is mostly discharged overside to lighter at river moorings.

Excluding coal, petrol, and overside discharge, and excluding berths restricted to laying-up, the volume of goods handled over quays and jetties in 1948-49 was 450 tons per lin. yd. per annum.

Calcutta is purely a terminal port, and is not a place of call of the passenger vessels on the eastern services which join Europe to the Far East. Regular sailings of cargo-passenger vessels connect Calcutta with East Africa and Durban, Rangoon, Singapore, China and Japan, and Australia, but it is rarely now that any ship carrying more than the statutory twelve passengers leaves for European ports. The heaviest passenger traffic has always been to and from Rangoon, and although this is now much reduced it is still the most important in numbers. The Rangoon passengers are embarked and disembarked at the large floating landing stage known as Outram Ghat, just below the Calcutta Jetties; this consists of four large pontoons and carries two-storeyed structures for Customs, offices, restaurant, etc. The overall length is 400-ft. and four covered gangways connect it to the shore.

Other than Outram Ghat no special provision has been made nor berth set aside for passenger traffic, but a proposal has been made for a new berth to be created for this purpose, complete with every necessary facility, on the site of the war-time troop-landing stages at Prinsep's Ghat.



New pilot vessel, *Hooghly*, converted R.C.N. Frigate.

The inland traffic handled in the port area is very considerable, and a large part of all tonnage moved in Bengal goes by water. The craft employed by the companies engaged in this trade range in size from 1,000-ton paddle steamers and converted L.C.T.'s, and covered flats of over 800 tons carrying capacity, down to country boats which rely on wind, current, and oarsmen. Along the four or five miles of river above and below the New Howrah Bridge, on both banks, there are some 45 structures—piled jetties and large and small pontoons with gangways—for the handling of goods, and of these eleven are calling places of the city's ferry steamer services. All are the property of and are maintained by the Commissioners.

COAL TRADE

At the time of writing, coal exports, including bunkers, average 275,000 tons per month. This quantity passes over 7 berths, of which two are partly mechanical and the rest entirely worked by manual labour, i.e., head-loads. The two mechanical berths, Nos. 19 and 20 Kidderpore Dock, each have five 8-ton hydraulic cranes; coal wagons are discharged by hand through side doors into rail level hoppers, which in turn empty into 5-ton buckets standing in pits. The buckets are raised by the cranes and discharge automatically through the bottom. Coal exports for a typical month (October, 1949), berth by berth, are as follows:—

No. 15 K.P.D.	43,700 tons
16 K.P.D.	24,750 tons
19 K.P.D. (mechanical)	39,600 tons
20 K.P.D. (mechanical)	33,100 tons
21 K.P.D	34,000 tons
29 K.P.D.	26,300 tons
Garden Reach	70,200 tons

No. 29 berth, it must be noted, is a general cargo berth only temporarily in use for coal, the quay cranes lifting tipping skips. A completely mechanical coal-loading plant, now being constructed at No. 18 berth, is described below.

The variation in the figures for the berths is not attributable to differing efficiencies, but to ship movements and other circumstances. For instance, the Garden Reach berth is worked in three shifts whereas the remainder are on two only.

THE PORT RAILWAY

The port railway system now amounts to a total track length of some 230 miles of standard gauge (5-ft. 6-in.), and it is connected to the main line of the East Indian Railway at Majerhat. There is also connection with the Bengal Nagpur main line by a railway ferry which operates from a special floating stage just above the Garden Reach Jetties.

The Commissioners own at present 54 locomotives, and 17 now on order remain to be delivered. The latest type was described in detail in " Dock and Harbour Authority," October, 1947, and the main particulars are as follows. It is a 0 : 6 : 2 tank engine, 65 tons total weight; it was designed to haul a 40-wagon train of gross weight 1,280 tons, and to take this load round a curve of 300-ft. radius. The locomotives were manufactured by the Hunslet Engine Co., Ltd., and the introduction of these powerful engines has resulted in a marked increase in general operating efficiency, and the lag in replacements caused by the war has now largely been wiped out.

NEW HOWRAH BRIDGE

The only crossing of the river at Calcutta before the last war was the floating bridge, opened for use in 1874. Under an Act of 1926 the Port Commissioners also became in a separate capacity the New Howrah Bridge Commissioners, and their Consulting Engineers, Messrs. Rendel, Palmer & Tritton, prepared the designs. The contract was awarded to The Cleveland Bridge & Engineering Co., and the steel superstructure, 28,000 tons, was fabricated in Calcutta as a sub-contract by the Braithwaite Burn & Jessop Construction Co. The bridge is a cantilever type with a main span of 1,500-ft. and anchor arms of 325-ft. The suspended span is 564-ft. long, and the towers rise to a height of 300-ft. above the river. The road width is 71-ft. between kerbs, giving 8 lanes of

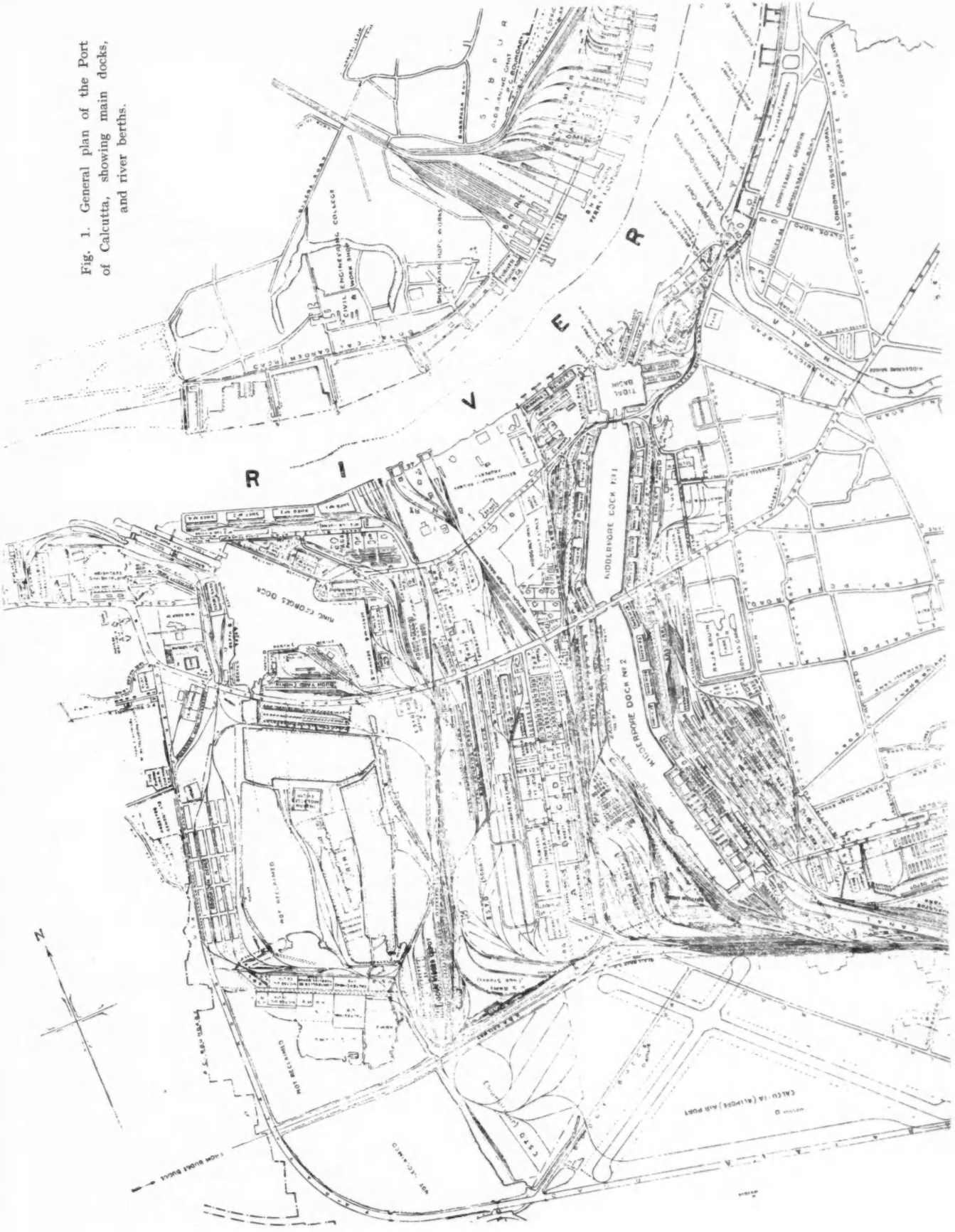


Fig. 1. General plan of the Port of Calcutta, showing main docks, and river berths.

The Port of Calcutta—continued

traffic, including the tramways, and the cantilever footpaths are 15-ft. wide. The bridge was opened towards the end of 1942, and needless to say the requirements of security at that time prevented any advertisement of the occasion. The bridge remains the responsibility of the Port Commissioners' Engineering Department.

THE RIVER AND VESSELS

From Calcutta to the sea at Saugor Island the 80 miles stretch of the Hooghly is famous, or notorious, as one of the most difficult of all navigable waterways, and it has been said that more vessels have come to grief and sunk at the "James and Mary" than at any other single point in the world. The pilot vessels lie off about another 50 miles from Saugor, and the total length of pilotage waters is thus 130 miles.

Commissioners have their own workshop for their maintenance. All of the larger craft—pilot vessels, despatch vessels, tugs—and principal shore stations are now equipped with radio-telephony, enabling them to keep in touch with Calcutta and with each other. In modern conditions the Hooghly has lost most of its terrors.

The latest addition to the fleet of dredgers is the *Jalengi*, built by Messrs. Simons of Renfrew, and delivered early this year. This vessel, which is a notable example of the latest technique in dredging, is designed to discharge astern into the stream as well as to hopper, and is capable of filling to capacity in as little as 40 minutes.

The keel has been laid, also in Messrs. Simons' yard, for a new despatch vessel, *Nadia*, 1,700 tons displacement, speed 12 knots, and delivery is expected early in 1951. In addition orders have

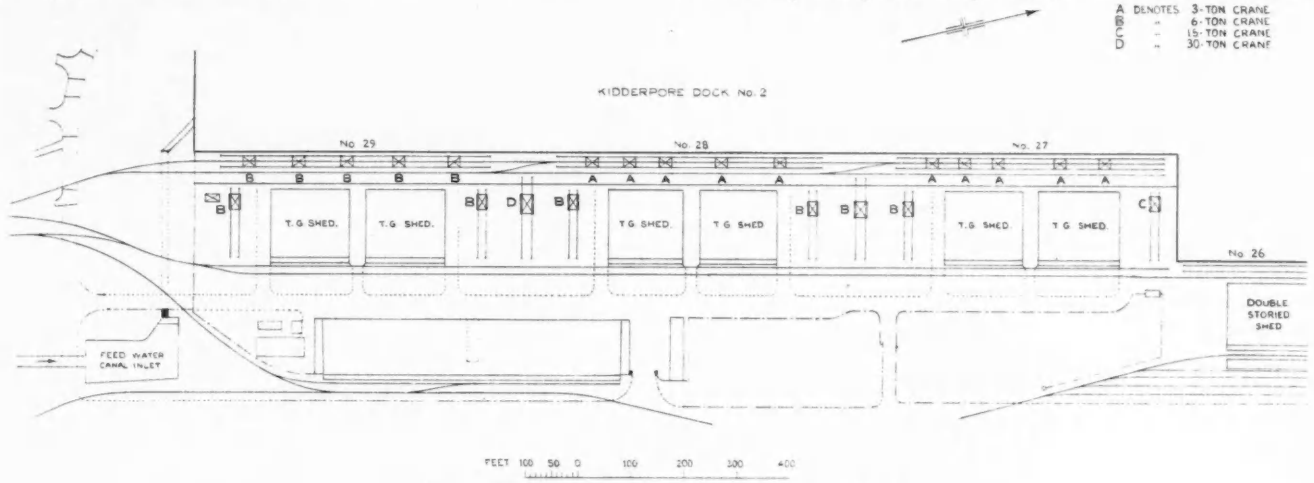


Fig. 2. Plan of Berths Nos. 27-29, Kidderpore Docks.

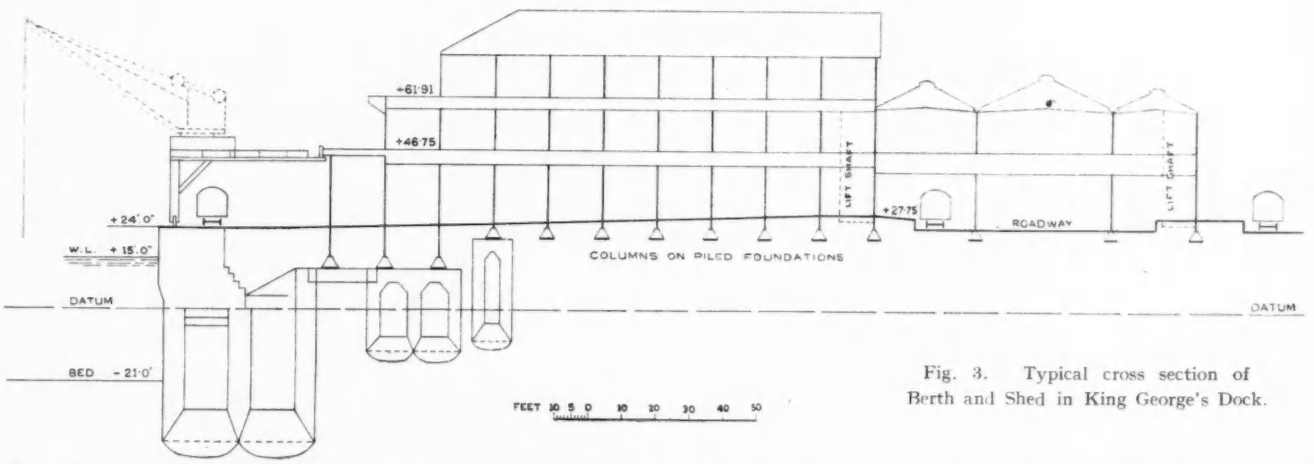


Fig. 3. Typical cross section of Berth and Shed in King George's Dock.

The Bengal Pilot Service, formerly an independent organisation directly under the Central Government, was transferred to the Port Commissioners in May, 1948, so that to-day the duties of river conservancy, survey, lighting and pilotage are united under the control of the Deputy Conservator.

Delivery was taken in 1949 of two new pilot vessels, ex-R.C.N. frigates, which were converted to their new purposes in Canadian yards. These, the *Bengal*, and the *Hooghly*, replace the *Andrew* and *Lady Fraser*, whose graceful lines and tall raking masts must have become familiar to more than a generation of mariners entering the port.

Recent years have seen a considerable increase in the number of lights on the river, and at present, excluding the numerous shore points, there are over one hundred floating lights between Calcutta and the sea. Mostly buoys, they are all gas operated, and the

been placed in Holland for a bucket dredger and attendant hopper barges.

Two tugs have been purchased in the last two years: *Empire Oberon* was bought from the Admiralty, and *Stalwart* was built by Messrs. Thornycroft's to the Commissioners' order. She is a twin-screw, steam-propelled vessel of 1,000 i.h.p., fitted with Kortz nozzles, and has a bollard pull of 19 tons.

RECENT DEVELOPMENTS

In recent years the most important changes and improvements in the port were those carried out towards the end of the war, when Calcutta became a great base in the campaign against Japan. Despite the nearness of enemy-held territory—under 300 miles—air raids were very few and damage slight, though on one occasion when bombs fell in the docks explosives and ammunition in ships

The Port of Calcutta—continued

and depots in the immediate vicinity amounted to scores of thousands of tons. Had the catastrophe of Bombay been duplicated in Calcutta the effects would have been incalculable.

This war-time construction was planned in 1944 by the then Chief Engineer, Mr. A. Webster, C.I.E., M.I.C.E., and it was almost entirely carried out in twelve months, being completed during 1945. We are here only interested in the works of permanent value to the port, and no mention need be made of the numerous and extensive depots, covered storage accommodation, timber jetties, marshalling yards, roads, and other facilities provided for the services and for the American Army. (See *The Dock and Harbour Authority*, December, 1946).

At the south end, east side, of Kidderpore Dock No. 2, three new berths were built and numbered 27, 28, 29. (Fig. 2). Designed for a deck loading of 10 cwts. per sq. foot they are of reinforced concrete beam and slab construction on Franki piles; the quay carries a portal crane track, 22-ft. gauge, and two rail tracks throughout, and the overall length is 1,880-ft. Each berth is provided with a pair of single-storey sheds, 146-ft. x 132-ft., of the well-known T.G. type, a temporary facility to be replaced in due course by more orthodox and much larger transit sheds. Yard cranes (portal type) of 6, 15 and 30 tons capacity serve the spaces between the berths, and again a pair of tracks runs the whole length behind the sheds. The spaciousness of quay and yards, and the easy access for road vehicles, are noteworthy features of these berths which have proved their value in the post-war years, and the generous crane equipment has well fitted them for the discharge of the heavy imports of machinery, railway rolling stock, and road vehicles which have come to Calcutta since 1946. Experience, indeed, indicates that it would be wise to retain the present layout, and not, in building new transit sheds of two or three storeys, to increase the covered space much beyond the area now occupied by the T.G. sheds. Imports from Europe and America generally tend to have a higher proportion of yard cargo than in the past.

In King George's Dock No. 1 Berth, though of permanent construction (monoliths), had been used mainly for laying up, and was provided neither with shed nor cranes. Here also T.G. sheds were erected, road and rail access provided, and 5-ton electric portal cranes installed on the quay. Similar cranes were provided at each end for yard use. This berth proved to be of the greatest value, and during 1945 the cargo figures topped 30,000 tons per month several times, the best being July with 37,600 tons.

An entirely new berth was constructed south of No. 4, and numbered 5. Unfortunately the necessity for speed and the availability of materials dictated a different method of construction which imposed a draft limitation. In King George's Dock water level is 15.00 to 16.00, quay level 24.00 and dredged level alongside—21.00. The new berth for formed of No. 5 Larssen steel sheet piles, 60-ft. long, which were obtained from the army, and the designed dredged level was—12.00; the anchorages, again formed of such materials as were then obtainable, also imposed restrictions and the permissible quay loading is 4 cwt. per sq. ft. instead of the usual 10 cwts. The transit shed was built up of T.G. units, and there being no new cranes available other older berths were robbed to provide No. 5 with 2-ton electrical portal cranes, running on a timber piled track. Strictly speaking this berth cannot be regarded as of permanent value with a permissible depth alongside no more than 27-ft., but it has been and is in constant use and other more urgent improvements are likely to be carried out in the port before this quay is closed for any reconstruction.

The Commissioners' already very extensive workshops have been improved since the war by alterations in layout, by the addition of new machinery, but principally by the construction of a new blacksmith's shop. This covers an area 240-ft. x 220-ft. and is a steel frame structure housing 14 pneumatic hammers from 1 cwt. to 30 cwt. capacity. A new bay is to be constructed during 1950 in the main workshops for the repair of locomotives. This will be 390-ft. long, 60-ft. in width, and will be equipped with 30-ton and 10-ton overhead cranes.

Typical modern quay and shed construction in the port is shown in Fig. 3, a cross-section of a King George's Dock berth. The

Alongside the old Calcutta jetties with the New Howrah Bridge upstream in the distance.

shed is 352-ft. long and 255-ft. in depth, with at each end a covered yard 144-ft. x 49-ft. The quay carries rail track and trolley lines, and is spanned by semi-portal 2-ton electric cranes, by Messrs. Stothert & Pitt. The width of the quay is an important asset in these days of increasing transport by road vehicle; grain imports, for instance, bagged on board, are delivered direct into lorries on the quay itself, as well as into shed and away by rail. Two platform lines serve the back of the shed, and the inside of the island platform is for road delivery. Electric lifts, eleven in all, are installed along both platforms. These sheds are of steel frame construction with brick panels, reinforced concrete floors, and asbestos-cement sheet roofing.

A recent improvement was the provision of the cantilever verandah to the top floor, which enables the quay cranes to deliver to any of the three levels.

This type of shed, covering an area of 90,000 sq. ft., may seem unusually large for transit purposes, but the intention in the design is that the top floor is for warehousing. The latest shed, at A berth, is similar in layout but has two floors only, and this is more likely to serve as the model for the new sheds which will be built in the near future.

A new and fully mechanical coal-loading plant (makers, Messrs. Fraser & Chalmers, Ltd.), is now in course of construction at No.

Berth No. 2, King George's Dock, showing 3-storied transit shed with verandahs and covered end yard space

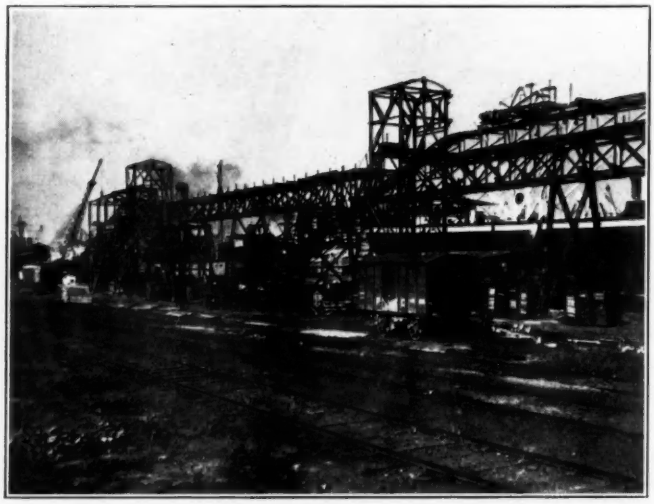
The Port of Calcutta—continued

The North-East Side of King George's Dock, from the Entrance Lock.

18 berth, Kidderpore Dock. In operation standard open wagons of 20-22-ton capacity run into two tipplers, whence the coal passes by rising conveyors to the main horizontal conveyor 40-ft. above ground level. Two mobile loader units take the coal from the conveyors and discharge by anti-breakers into ship's holds. The rated capacity is 250 tons per hour for each unit, or 500 tons in all.

The mobile loaders towers are very heavy pieces of plant, running on 30-ft. gauge track, and in worst wind conditions they impose a maximum corner load of about 110 tons upon the sub-structure. The berth that was built to carry this plant is of particular interest as it is designed to be removable for re-erection elsewhere. (See Fig. 4). There is a possibility that in the future all coal traffic may be moved to the extreme west side of an enlarged King George's Dock, which would entail the transfer of this new equipment, a contingency borne in mind and allowed for.

The main girders under the rails are carried by two rows of C.I. screw cylinders at 20-ft. centres; the cylinders are 3-ft. in diameter, cast in 9-ft. lengths, and bolted through internal flanges. The screws are 6-ft. in diameter. The back of the quay is carried on 22-in. diameter Franki piles, also a 20-ft. spacing. The deck system is of main plate girders with secondary steel beams, on which are laid pre-cast vibrated reinforced concrete slabs, 12-in. x 6-in. x 6-ft. 8-in. long. Thus, with the exception of the Franki R.C. piles, the whole of the structure and its screw piles can be dismantled, removed and rebuilt.



New mechanical coal loading plant under construction at Berth No. 18, Kidderpore Dock, showing conveyor bridges and tipplers.

In common with so many ports, Calcutta was equipped with a hydraulic power system operating lock gates, capstans, shed lifts, and quay cranes. With few exceptions the hydraulic quay cranes are all of 35-cwt. capacity, but in to-day's conditions they lack capacity, reach, and speed, and a programme of replacement has been prepared to be carried out during the next few years.

Towards the end of the war, with the priority accorded to the port by the highest authorities, the Commissioners were able to obtain some forty or so modern cranes of varying types and capacities. They were, of course, all new, and originated from both British and American makers. Power units were mostly electric, but some were straight Diesel, other Diesel-electric. Those installed on the quays were 3, 5 and 6-tons capacity, and in yards there were 10, 15 and 30-ton types.

In King George's Dock and the Garden Reach Jetties all ten berths are equipped with electric portal or semi-portal cranes. In Kidderpore Docks, only the three new berths and yards, Nos. 27-29, have the modern cranes, but it is intended to replace the hydraulic equipment on berths 22-26 in the near future. The new ones will be 3-ton, all electric, semi-portal type.

A sheerlegs between Nos. 5 and 7 berths in Kidderpore Docks has a capacity of 100 tons. Steam-operated self-propelled floating cranes, *Atlas* and *Sampson*, lift 60 and 30 tons respectively. A dumb floating crane, 20 tons capacity, is largely used on ship repair and similar works. At the end of the war the Commissioners acquired from Disposals two American-built pontoon derrick cranes, each of 30-tons maximum capacity, with Diesel-electric power units. The port thus has ample facilities for dealing with heavy imports of machinery, locomotives, castings, and the like, up to the 100-ton limit.

A direct result of post-war industrial expansion and of the many major works (hydro-electric schemes, the Sindri fertiliser factory, power station construction, etc.), undertaken by the Government has been a notable increase in the number and magnitude of heavy packages arriving in the port. Locomotives numbering hundreds have been ordered abroad, and one class exceeds the 100-ton limit of the sheerlegs. Locomotives, however, can be surgically treated, and by removing the leading and trailing wheels the figure has been reduced to ninety-odd tons. Electrical machinery cannot be so abused, and already lifts of the order of 130-140 tons have been removed from vessels in the port by the combined use of the sheerlegs and the *Atlas*. Such expedients are naturally not popular with anyone concerned, and the Commissioners are now proposing to instal a fixed crane of 200-tons capacity in King George's Dock. It is hoped to see this crane in use in about two years.

The Commissioners' property in the port area proper extends in a straight line some $2\frac{1}{2}$ miles southward from the river and covers about 6 sq. miles; this is excluding the long strips on both banks of the river and also the Budge Budge oil depot. Fully one-third of this area, south and west of the docks, is little developed yet, and considerable portions, now swamps, have still to be reclaimed.

Water is supplied to Kidderpore Docks from upstream via Tolly's Nullah and the 2-mile Chetla Canal. The silt in suspension is dropped in the canal, whence it is removed by small steam grabs and conveyed to a silt pumping plant near Majerhat Station. The whole of the "Alipore Aerodrome," a war-time R.A.F. field, was reclaimed in this way, and this is the site of the present estate development. Hide Road has been extended southward a distance of $\frac{3}{4}$ mile, Taratolla Road has been widened to a 40-ft. carriageway, and other branch roads are now under construction. Railway tracks are being laid to serve the lessees of the various plots, and an entirely new main drainage system is also being created.

West of the extended Hide Road is the site of a new grain and storage depot, of which the first two sheds of a projected 32 have been completed. These are single-storey steel structures, 390-ft. x 90-ft., with C.G. side sheeting and A.C. roofing, with rail and road access to every shed.

MECHANISATION

In view of the considerable imports of food grains and of the steady export trade in gunnies and tea it may well be asked whether up-to-date mechanical handling methods would not be justified. To take a comparable example, the Port of Manchester

The Port of Calcutta—continued

in a normal year (1936) imported about 770,000 tons of grain and flour, and is well-equipped with pneumatic elevators, subway conveyors, and bulk storage elevators. The conditions in Calcutta, however, are very different, and after close examination of pneumatic and mechanical means of discharge it was found not economic to mechanise. Imports of grains are most irregular in flow, and an increasing proportion arrives ready bagged; from the port the grain is sent in bags, by rail and road, to a number of different destinations, and not, as is common in the U.K., to one nearby milling centre. Finally, it is the policy of the Government so to increase the country's production as to reduce imports to a minimum in the next few years, and it is hoped to see them cease altogether.

Tea reaches the port by rail and by river in the standard chests of 120-140 lbs. each. In their passage from barge to warehouses, to the transit sheds and finally to the crane sling, they are entirely man-handled, unless lifts and porter's trolleys can be regarded nowadays as mechanical handling. It is not practicable to devote one or two berths to tea export only with mechanical equipment, so loading will continue as at present. There is, however, a good case to be made for the installation of conveyors at the river landing point to transport the chests from barge to warehouse, and also for case-elevators in place of lifts, and proposals on these lines have been examined and are likely to materialise in the near future.

In the conditions obtaining in the Port of Calcutta the only forms of mechanisation likely to be justified on all grounds are portable elevators for high stacking in sheds, portable conveyors for the elimination of long carries by labour, and the increased use of powered trucks in their various forms.

THE FUTURE

Something of the future programme has already been indicated —replacement of war-time sheds, modernisation of crane equipment, new vessels, and the 200-ton crane—but the two biggest items are the extension of King George's Dock, and the improvement of the port approaches.

As to the first, planning is based on an ultimate provision of about 30 berths in the fully-extended dock, and it is probable that the first stage will see three general berths and a heavy lift berth and yard. It is not the intention to replace the river jetties as their useful life comes to an end, hence traffic will tend more and more to concentrate in the Kidderpore area.

The second is a problem of greater complexity. A proposal has been made for the construction of a ship canal between Calcutta and Diamond Harbour, a length of 30 miles, the intention being to by-pass the upstream bars with their heavy burden of dredging and limitations upon shipping. Before any decision is taken, however, means of improving the river channel are being investigated by tidal model. The first of three models has been built at the Research Station of the Central Waterpower, Irrigation & Navigation Commission, at Poona, under the direction of Rai Bahadur D. V. Joglekar.

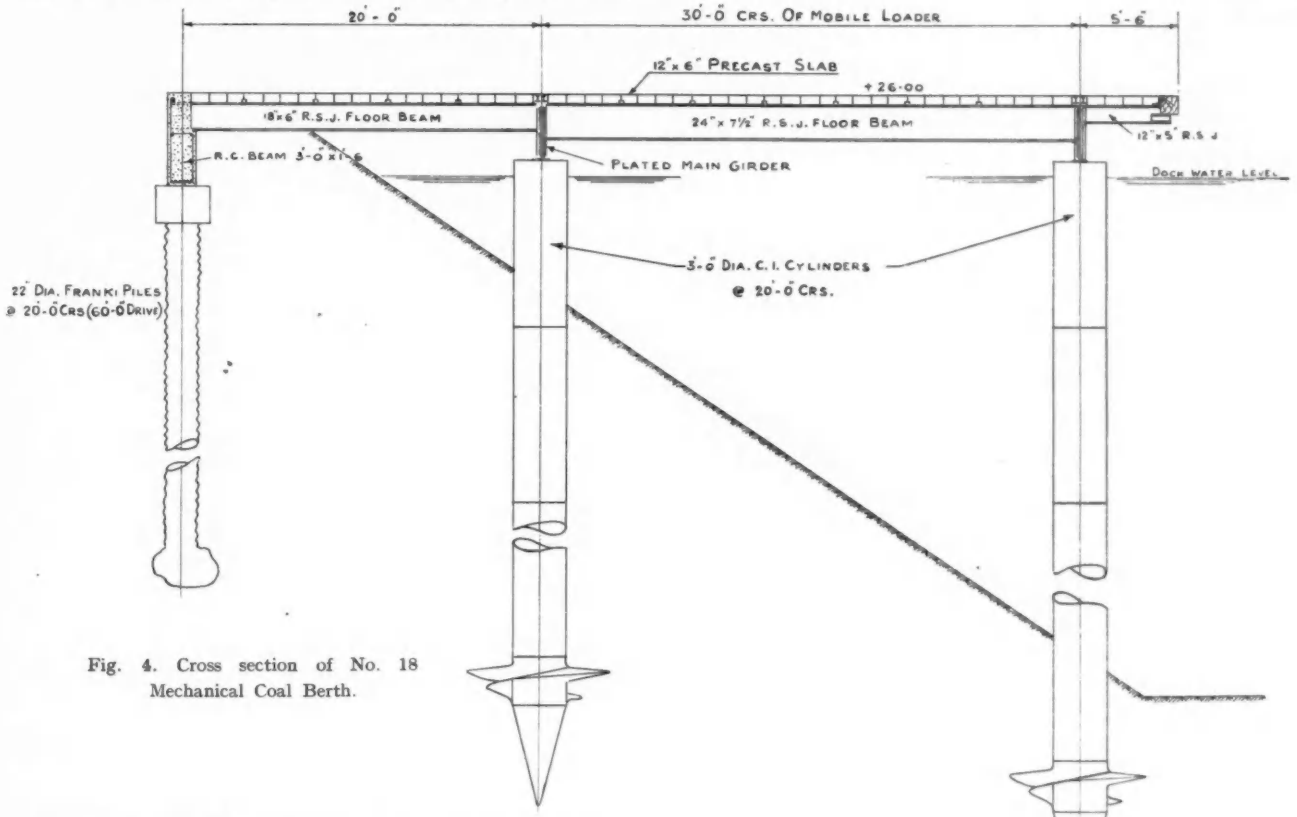


Fig. 4. Cross section of No. 18 Mechanical Coal Berth.

This model has a horizontal scale of 1 : 2000, vertical 1 : 160, and covers a length of about 150 miles, from open sea to well above Calcutta. It is built in the open and is 450-ft. in length. The tributaries are included, and tidal operation is by sliding weir. The tidal cycle is $4\frac{3}{4}$ minutes and the actual influx of 50 million cusecs is represented in the model by 12.5 cusecs. At present this first model is being proved, and in due course it is the intention to study the port area and upper reaches on models of bigger scales. It will naturally be some considerable time before results are obtained which will enable firm decisions on long term policy to be taken. Meanwhile, there is sufficient work projected in the immediate future to enable it to be said with confidence that the next few years will see the Port of Calcutta continuing to expand and improve, and capable of meeting any demands that may be made upon it.

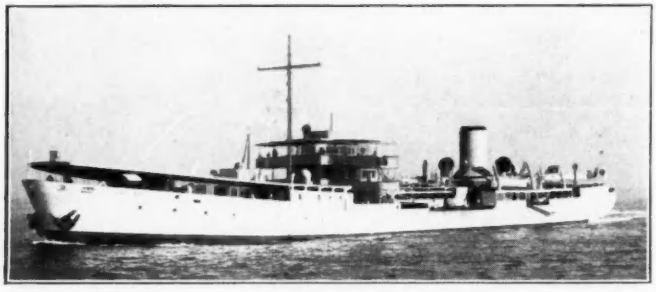
New Dredger for Port of Calcutta

Description of the "Jalengi"

As mentioned in the foregoing article, the latest addition to the fleet of dredgers operating at the Port of Calcutta is the *Jalengi*, built by Messrs. Wm. Simons & Co., Ltd., of Renfrew, Scotland.

The dredger has been designed for service on the River Hooghly and, in particular, for working in the Eastern Gut Bar of the James and Mary Sand. The depth of water on this Bar varies from 21-ft. after the rains, to 6-ft. at the end of the dry weather season. The objective in view is the maintaining of a navigable channel with a depth of 14-ft. at L.W.O.S.T. The navigation of the bar is confined almost entirely to the flood tide and dredging must take place day and night on the ebb tides which run for approximately 8 hours. The dredger is intended to work under way, steaming into the tide, and is required to work in the worst conditions in strong currents. The currents on the bar are very strong and in spring tides often reach a speed of 8 knots.

The new vessel will form a notable addition to the dredging fleet at present operated by the Calcutta Port Commissioners. The other dredgers are the *Sandpiper* (built in 1906) the *Balari* (built in 1913) and the *Gunga* (built in 1921); all were constructed by Messrs. Wm. Simons & Co., Ltd., and have been constantly at work on the River Hooghly since their arrival there.



The *Jalengi* is of most modern design and embodies many new ideas suggested by the officials of the Calcutta Port Commissioners, and has been constructed and equipped in accordance with the specification of the consulting engineers, Messrs. Rendel, Palmer & Tritton, of London. The leading particulars are as follows:

Length between perpendiculars ...	350-ft. 0-in.
Breadth, moulded	62-ft. 0-in.
Depth, moulded	24-ft. 0-in.
Mean Draft	16-ft. 6-in.
Hopper capacity	3,000 tons.

The Hull and Machinery have been constructed under the inspection of the Surveyors of Lloyds Register of Shipping for Special Survey and classed 100 A.1. The Ministry of Transport requirements, as regards equipment and accommodation, have also been satisfied.

The dredger is of the single-deck type, the propelling machinery and boilers being placed abaft the hopper and pumping machinery placed forward of the hopper, with the suction frame well situated immediately forward of the pump room. The hopper is placed amidships and is fitted with hopper discharge valves of large diameter for discharging the spoil through the bottom of the vessel. These valves are operated by means of hydraulically-operated rams, situated on girders which run the full length of the hopper and above the level of the hopper coamings.

The *Jalengi* is capable of dredging spoil from a depth of 45-ft. below light water line, and can fill the hopper with 3,000 tons of sand in 30 minutes. The spoil is discharged from the dredging pump into the hopper through a 45-in. bore pipe led over top of hopper at centre line. A special feature of design is the hydraulically-operated discharge doors in this pipe. The discharge pipe is continued past the hopper over the engine and boiler casings to the stern so that, when the discharge doors are closed on the hopper, the spoil can be continuously discharged over the stern and carried away by the currents, thus saving time in having to leave the dredging ground to discharge a load in the hopper.

Wellington Harbour Board, New Zealand

Excerpts from Chairman's Address

At the 68th Annual Meeting of the Wellington Harbour Board, held on 22nd March, 1950, Mr. W. H. Price, Chairman of the Board, said that although a small increase was recorded in the net tonnage of vessels arriving, 3,295,128 tons this year as against 3,201,509 tons in 1948, there was a decline in the total tonnage of cargo passing over the wharves of 191,607 tons. This recession in trade can largely be attributed to the substantial reduction in imports from Australia (61,028 tons) where serious industrial troubles during the year have no doubt been a contributing factor. The stocks of wool accumulated during the war years were mainly cleared and shipped in the previous year, and this has resulted in a large reduction of 69,435 bales in the shipments of wool in the year under review; there was also a substantial drop in frozen meat exports amounting to 23,922 tons.

The downward trend in trade is also reflected in the financial results for the year, the year's working revealing a net loss of £25,835 after allowing for the usual annual appropriations. Revenue for the year decreased by £55,302 as against a decrease in expenditure of only £20,453. A study of these figures shows that the diminution in revenue receipts has not been offset by a similar reduction in working costs and it is evident that the full effect of wage increases and rising costs is now making itself felt. A slight recovery in trade during the early part of the current year has resulted in an improvement in the revenue position, but this has been more than absorbed by the ever-increasing costs.

The excess of Assets over Liabilities is now £2,721,401 which is a satisfactory position.

PORT IMPROVEMENTS

It is gratifying to know that since the easing of the position regarding building permits, it is now possible to make good progress with the Port Development Programme, and with a view to the importance of providing additional storage accommodation and to developing the existing berthage at Aotea Quay, it was decided to press on with a schedule of works required to develop the quay to the stage when it will provide facilities for the bulk handling of coal and cement, two completely equipped Stores—a new Store No. 51 besides the present Store No. 49—sixteen electric wharf cranes, and a crane rail the full length of the Quay.

The total cost of this programme is estimated at approximately £524,000 spread over a three-year period and, in accordance with a recent decision of the Board, negotiations are at present in train for the raising of a loan of £400,000 to be expended in connection with this work, the balance of the amount required being provided from the Board's own funds.

Some of these works have been delayed for several years, owing to the Board's inability to obtain building permits, due to the shortage of steel, cement and other materials. These materials are now coming to hand, mainly from England, but at greatly enhanced cost as compared with pre-war values.

Work on the construction of No. 39 Shed is now progressing steadily. The four electric cranes for this Store have been delivered and it is hoped to have this modern shed in operation about the middle of the year, this will give an additional storage capacity of 4,500 tons.

During recent months a very difficult period has been experienced due to congestion of cargo on the wharves, and at the present time the stores and facilities are being taxed to capacity to cope with the situation. The Cargo Control Committee is fully aware of the position and is making every effort to overcome congestion at the port. Due to many factors, congestion is a problem which periodically presents itself at every port, but the completion of the other large store (No. 51)—estimated to be available for use in 1952—will increase the storage capacity on the wharves by a further 10,000 tons and will assist considerably in reducing congestion. The necessity for increased shed accommodation at the present time has been accentuated by the operation of the 40-hour week, with a consequent reduction in the hours for delivery from the Board's sheds, whilst the discharging of vessels is carried out over a 59-hour week.

The Handling of Import Cargoes

With Special Reference to Problems at Middlesbrough

By W. A. LAKE.

A PAPER by Mr. W. A. Lake upon the subject of Import Cargoes was read on the 3rd February last, before the Middlesbrough Section of the Institute of Transport. As some of the problems discussed are not confined to docks on the Teesside, but are applicable to many other ports, we are printing below, by kind permission of the Institute of Transport, the salient points which we consider to be of general interest.

THE GENERAL AIMS OF PORT OPERATION

The Minister of Transport in June, 1948 stated in a letter to port authorities and associated bodies:

> " An improvement in the turn-round of ships will not only contribute to the efficiency of our mercantile marine and of our national economy as a whole, but, at the present time, will also mean a valuable saving in dollars or other hard currencies or an increase in our power to earn foreign exchange."

The importance of an expeditious turn-round of shipping has been brought home to the average citizen both during the recent war and during the post-war period, but it is evident the term " turn-round " is not fully understood by those not connected with shipping business.

It is my aim to present to you some of the problems associated with different types of cargoes arriving in Middlesbrough, to show how the variety of types calls for differing treatment and how problems, quite " outside the book," arise with every different commodity that enters the port. As a background to these special cargoes, I should like to point out the general problems with which the port operator is concerned. His chief aim, provided the port operation is not subsidiary to another industry, must be maximum berth user, to ensure the maximum income per foot of quay, with vessel following vessel at each available berth. All I would say in connection with this, is that maximum berth user is not synonymous with a maximum number of vessels within the quay area, but rather an " optimum " number, sufficient to make a full use of all berths but not so many as to lead to congestion and delay to the main operation of despatching the vessel.

Allied to this problem is the fact that berthage accommodation must be arranged in advance by the shipowners' agent at the port, but there are many factors contributing to make the actual date of arrival of a vessel a few, or sometimes several, days later than the anticipated and advised date of arrival, e.g. weather conditions, labour disturbances and delays at intermediate ports. Consequently a berth may be empty in spite of the most careful preparations of the operator, or the good intentions and, sometimes, unwarranted keenness of the shipowners' agents.

Having provided, so far as is he is able, for the maximum berth user, the operator's object must be to make the ship available to the shipowners' requirements as quickly as possible with the booked cargo loaded, or the cargo specified for that particular port discharged, according to whether cargo has to be loaded or discharged, and in fulfilling this aim, he must provide for the quickest possible disposal of the cargo from the transit area with the minimum of handling. I think the necessity for this will be seen, if this transit area is regarded as a corridor or passage way of limited capacity. If this corridor is blocked, then the stoppage must be cleared before other cargo can flow through it, and if the stoppage is not removed, then the output from the ship must cease.

The normal flow of some traffics is quicker than that of others, e.g. Iron Ore is discharged direct from ship's hold to railway wagons which are immediately ticketed and placed at the disposal of the Railway Executive to be hauled to their final destination. On the other hand, general cargo, in containers of one description or another, are almost invariably held up to await Customs examination, which, if the agents have not been able to obtain the necessary licences, invoices and other required documents, is not carried out for some days. I would point out, however, in this connection that " quickest possible disposal from the transit area " does not mean that the port operator is not concerned with the storage of traffic he receives ex ship. Indeed, the greatest Warehouse keeper in the world is a port authority, the Port of London Authority. Nevertheless, if goods are for storage, they are still passed through the transit area as quickly as possible to warehouse or storage grounds specially allotted for that purpose and away from the quay front. In conjunction with these main aims of the port operator, he must always have in mind the safety of the ship, to which he warrants safe berthage in his offer of berth accommodation, and the safety of the cargo, for which, when it is clear of the ship, he is responsible as bailee to the owner.

THE PARTICULAR AIMS AND PROBLEMS CONNECTED WITH INWARD CARGOES

From the general aims, I should like to proceed to the particular aims and problems connected with inward cargoes. Provided by the agent with a cargo plan or information as to the nature and stowage of the cargo and particulars of the vessel, he must arrange in advance for the provision of adequate craneage, labour and transport. With regard to craneage, the problem does not simply resolve itself into the provision of a crane at each cargo hold where there is cargo for discharge or, on the other hand, a division of all available cranes among the hatches to be worked.

More economical working can sometimes result from the provision of only two cranes instead of three, or five instead of seven of eight, for surplus crane capacity does not always mean an improvement in the turn-round time. This will be appreciated when it is realized that among the reasons are firstly, that the holds of ships are not equal in capacity, secondly that some cargoes are more quickly discharged than others and again that a confined working space may preclude the working of more than one crane or, if a second crane is employed, lead to a considerable slowing down of the rate of discharge of the first.

The provision of adequate transport to receive the incoming cargo is quite a problem and in Middlesbrough has been a source of worry until recent months, because of the preponderance of Ore in the tonnage handled. Having received disposal instructions from the consignee or agent, with particulars of the means of carriage to be employed, whether road or rail, or maybe water, the operator must arrange for these to be available at the time required after the commencement of discharge, ready to receive the goods from the appropriate holds.

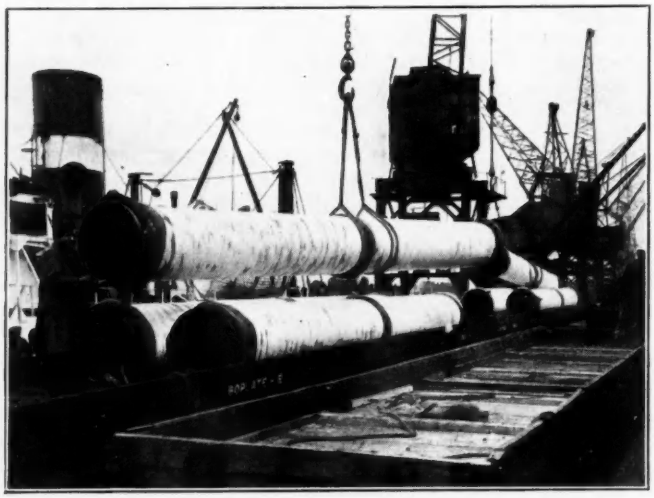
In the case of railway wagons, the most suitable type must be ordered, goods wagons, bottom-door ore wagons, plate wagons, bolster wagons, and so on, and once having obtained them, no difficulty attaches to shunting them to their appropriate positions on the quay. In the case of road transport, however, no motor transport operator is likely to permit his vehicle to stand on the quay, hours in advance of the arrival of the ship, in the hope that the cargo for collection will be immediately obtainable for him on the ship berthing, so that cargo for despatch by road transport must generally be discharged first to shed and reloaded to motor, unless as is the case with a commodity to which I shall refer later, the cargo is in bulk and a fleet of lorries can be made available to work a shuttle service between the vessel and the nearby consignee.

A road vehicle cannot, as can a railway wagon, act as a small buffer depot to store the goods to await the convenience of the consignee or to receive its load with the least inconvenience to the loader and at the rate the latter is able to load. In spite of the

The Handling of Import Cargoes—continued

exhortations we constantly hear to " turn wagons round quickly" it still appears to me that the fact that a railway wagon is not self-propelled militates against its immediate unloading or loading in certain exceptional circumstances and enable it to perform a necessary function in private sidings working that the road vehicle cannot perform, until the day when motor engines are as cheaply and readily produced as axle boxes, or motor lorries have completely given way to the tractor and trailer.

The provision of an adequate labour suppply is now, fortunately or unfortunately, outside the control of the port operator. He can merely request the number he requires and hope that the National Dock Labour Board will meet his request. You have already heard, from one of our members, of the organisation of labour within the docks industry and I need only remind you of the fact that an order for a number of workers results in a financial obligation to that number, whether or not they are all found employment.



Shipping Fabricated Pipes (about 2 tons each) per S.S. *Rutland*.

It will be appreciated, therefore, that an accurate estimate of the workers required is essential if economical working is to be obtained and, so far as he is able, the port operator must ensure that his order is for the exact number of stevedores, hatchwaymen, quayworkers, etc. that the vessels require for speedy and efficient working. Nevertheless, delay in the arrival of a vessel can still result in thirty or forty men being paid for doing no work at all. Moreover, although classification of workers into the two grades—A for all duties and C for hatchway men, etc., is carried out by the N.D.L.B., different cargoes call for different types of workers, e.g. the Iron Ores for the " stone men," timber for those whose experience makes them specially qualified to handle timber.

This choice of individual workers to be employed, presumed to be open to the normal employer of labour, is no longer the general rule in port operation and the undertaking must generally depend for the quality of the worker on the local representative of the N.D.L.B. Special arrangements are sometimes made for a representative to attend the call point, and, of course, the system of " allocated " workers does away with a lot of difficulties attached to this problem. This system of " allocated " Workers, by no means widely adopted throughout our ports, means that a certain number of men are allotted to a particular wharf or employer, and provided that wharf or employer has work, then that is the first place of employment for the allocated man.

Among the particular problems attached to cargo handling, I should like to say a word as to the means employed to transfer the contents of a ship's hold to the quay—(whether it be to railway wagon, motor transport or on to the quay surface itself). No doubt, a prolonged study of the discharge of one particular type of commodity would result, eventually, in the best possible means of such discharge suggesting itself, similarly, in the case of other types of cargoes. The problem here, however, is the unattainability of the ideal, since the average public quay or dock operator is called upon to deal with many different types of cargoes as bulk ores, drums of chemicals, crates of plywood, bags of flour, unpacked machinery and mixed scrap.

It is obvious that a special berth cannot be set aside for each particular commodity, specially constructed and equipped to deal with that particular commodity as expeditiously as human ingenuity and scientific invention allows—giant Ore Unloaders for the iron ore berths, specially constructed cranes for the Scrap, and conveyors for standard sized packages. If such were the case, the docks or quays to serve a region would require to be almost as big as the hinterland itself.

The problem is to find some appliances that can be readily adapted to deal expeditiously with any cargo that is offered and although the electric rail-mounted level luffing crane, which can be readily fitted with patent grabs, cargo tray, sling chains or tub, has been a boon to the port operator, ample room is left for his ingenuity in dealing with the individual cargoes. The same class of commodity may be dealt with differently from port to port. Bacon is reputed to have said, " We think according to nature; we speak according to rule; but we act according to custom." And the latter is often true of port work—the custom of the port, which often includes restrictive practices, generally governs the method by which a particular cargo is handled.

Before I proceed to deal with individual cargoes, I should mention the difficulties which spring from the fact that the ship is on a different plane from the quay to which the cargo is being discharged, and moreover afloat on a water surface, consequently, in the case of berths outside an enclosed dock, she must be securely moored to guard against a strong tide and heavy weather. Unless care is taken in the siting of bollards, mooring ropes can be more than a necessary evil to the quay staff and could prove an obstacle to the easy movement of traffic on the quay. It is conceivable that they could close up quay railway lines for varying periods, which may prove lengthy periods if the vessel is a large one looming high above the quay level and whose chief officer deems it wisest to unloose the mooring ropes only at the next low water! Moreover, the spring tides can even render a small jibbed crane completely ineffective if the freeboard of the vessel to be worked is great.

Having made the necessary preparations as regards craneage, transport and labour, that is, the provision of facilities to get the cargo on to land transport, the operator must, as I have pointed out, ensure firstly a speedy clearance from the quay of the loaded transport, by ensuring, so far as he can, that release of the cargo has been granted by the shipowner (or his agent), for until his freight and charges are paid he has a lien on the goods and can refuse to let them out of his possession. Secondly, he must have disposal instructions from the consignee and, thirdly, if necessary, clearance from H.M. Customs.

Unfortunately, his own careful preparations may be set at nought by the failure of the consignee to pay duty promptly, or produce an Import Licence required by H.M. Customs so that clearance from the transit area may be retarded. Finally he must ensure that the quay staff are fully instructed as to the necessary steps to be taken in the passage of the cargo from the ship through the quay area to the point they leave the custody of the quay authority, and provide for a minimum number of handlings to avoid unnecessary cost and damage.

IRON ORE AND SCRAP

The main inward cargoes of Middlesbrough are precisely those one would expect of the main iron and steel region of the country. With the steel industries breaking output records, it is only to be expected that the import of iron ore to Tees-side it at a high level. The blast furnaces from Skinningrove to as far north as Consett receive ore from vessels discharging in Middlesbrough. Although it was with the object of developing Middlesbrough as a port through which coal from the Durham coafield could be exported that Edward Pease with his associates planned the early

The Handling of Import Cargoes—continued

days of the port, it was the exploitation from 1850 onwards of vast beds of iron ore in the Cleveland district, that led to its present-day importance. Now, the quantity of locally-mined ore is steadily falling, but nevertheless the establishment of the iron and steel works and ancillary industries gave the necessary momentum to justify present-day tonnages of iron ore imports. Imports of scrap at its present high level—may be considered a result of the 1939-45 War and the consequent bomb damage, reparations and dismantlement, and the iron and steel industry has had its Ore imports supplemented by the " battlefield scrap " with consequent advantages to its natural port of Middlesbrough.

Under the system of bulk purchasing by the Government at present practiced in the case of many commodities, the provision of warehouse space is a valuable inducement to the Ministries to use a port so providing and this applies to a degree in the case of the Insulation Board and Hard Boards imported into the river (included in General cargo in the Schedule). Moreover, the proximity of Messrs. Imperial Chemical Industries must certainly mean addition trade to a port and so it is in the case of Middlesbrough.

The ideal means of discharge of iron ore is probably difficult to see. The giant unloaders as used on the Great Lakes of North America are only there the ideal form because the ore carriers are highly specialised vessels with the hold continuous throughout and hatchways of hold dimensions, the capacity of the grab being 15 to 20 tons. With such specialisation, immobilisation of quay space is not a factor for consideration since that is the purpose of the quay space. Unless vessels are specially constructed for the one class of cargo they are not easily adapted to suit the convenience of the handling appliance. A compromise must be sought in our case. We have in the Tees, of course, the example of berths used solely for ore discharge, e.g. the South Bank Wharf of Messrs. Dorman Long & Co. Ltd., but even there, unloaders have their disadvantages in that they are unable on account of their high capacity and limited manœuvrability, and the nature of the vessels themselves completely to " clean up " a vessel, which must therefore move to another berth for this purpose.

However, despite the fact that the vessel has to move to another berth to complete its discharge, the rate of discharge under the Ore unloaders is such that the overall time of discharge of a 9,000 tons cargo is shortened by three to four days. The unloaders are discharging an average of 75% of the total at an average rate of 1,300 tons per unit per shift—and it is a common thing to have a discharge by the two units in one day (two shifts) of 6,000 tons. The capacity of the Unloaders is demonstrated by the discharge on one shift—by the two units—of 5,000 tons of Swedish Ore.

Where such specialisation is not the case, as, for example, at the public wharves, the compromise is found in the attachment of grabs to the travelling electric cranes, or a tub of about 2 tons capacity. The port operator must first decide the means of discharge and, generally speaking, a grab is used as long as possible and until the hatch is " bottomed " in the square of the hatch, to give the shovellers the benefit of a working space and a " bottom " from which to shovel. This is not invariably the case and shovelling may be attempted from the beginning of the discharge. Even grabbing may be a very slow job, for if the Ore is very hard and lumpy the crane is liable to come out of the ship many times before one wagon is filled. Morover, the grab cannot, by virtue of its grabbing motions alone, clear ore from the corners, pockets and recesses of the holds, and shovelling must necessarily be resorted to. This does, of course, ensure that every load taken out of the ship by the crane is a full tub, but again it may be very slow on account of the nature of the ore itself, or for the reasons referred to below.

The normal ore wagon on the North Eastern Region of British Railways, is the metal bottom door hopper type of 20 to 25 tons capacity. When you imagine that for the tonnage shown on the schedule, 2,700,000 tons, 135,000 wagons have been needed during the year for loading this tonnage, since almost all is discharged direct to wagons, the importance of an adequate wagon supply and the seriousness of a shortage of wagons can be realised. Although the situation has eased considerably during the last few months, vessels have been seriously delayed in discharge because the wagon supply was only sufficient to warrant the service of one or two cranes whereas four or five would normally have been provided if the wagons had been available. One factor contributing to this shortage has been the failure of the consignees to tip the wagons promptly on arrival with the result that wagons have stood under load for days unnecessarily.

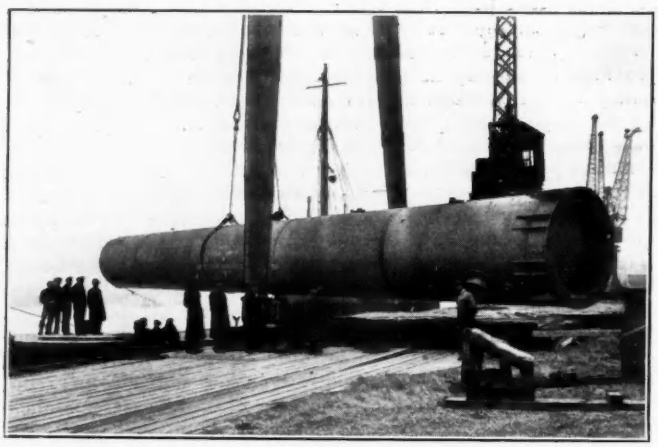
I have pointed out that the iron and steel works require another raw material to supplement the iron ore imported by them, that is, Scrap Iron and Steel. During the post-war period, enormous quantities of Scrap have become available from the Continent as a result of bomb damage and reparations. The result has been a continuous stream of vessels into the Tees with every shape and size of Scrap from a washer to a 19-ton roll. Again unlike the case of homogeneous cargo, the rate of discharge is rather uncertain, but in the case of these cargoes, with a few exceptions, the carrying vessel is of a smaller type and unlikely to occupy the berth any considerable length of time. In this case, no inducement is offered to the men to claim for extras or awards as a standard rate—but a very high standard rate—is paid for all scrap, varying only according to whether the scrap is bundled, cast iron or steel scrap.

New Ore Unloaders at Cleveland Works of Dorman Long. These two unloaders are capable of discharging a maximum of 350 tons of ore each per hour. The boom of the rear unloader is being lowered in preparation to bringing the grab into operation.

The means of handling employed in the Tees is either by grab or by trays (the equivalent of the tubs in Ore discharge). In the case of Scrap, the grab—a spider grab differing in construction from the Ore grab—has a much more limited use as the nature of the Scrap itself may make the grab almost ineffectual. Nevertheless, for small scrap stowed tightly and especially for cast iron scrap, the grab can result in tonnages higher than those that could be obtained by the holdmen handling each piece into trays. However, chains and trays must frequently be resorted to, chains being used when the weight of the pieces exceed the capacity of the stevedores, to lift the pieces on to trays or directly out of the vessel. Though having the appearance of being rather a primitive means of discharge, I should say that this latter method is very effective and to see the experienced workers " dipping " with their chains for the bigger pieces and the crane coming out with a load by no means far short of the capacity of the crane, is an education to the less experienced. Moreover, a serious problem arises in the use of the scrap grabs in that the pieces may frequently be the last straw—though rather a heavy straw—to break the wagons back, and wagon claims can be a serious problem unless the crane-driver exercises the necessary amount of care in the operation of his grab, as is expected of him.

In the handling of scrap, an interesting feature is the type of vessel arriving in the Tees with these cargoes. They are usually

The Handling of Import Cargoes—continued



Absorber (82-ft. long and weighing 42 tons), awaiting shipment at Dent's Wharf, Middlesbrough.

Dutch vessels with a shallow draft and consequent high manœuvrability, able to berth at any state of the tide and with the maximum of cargo space, being generally motor vessels with no bunker space. Their big hatches facilitate discharge and lead to a speedy turn-round. On the other hand, a liner of 5,978 tons n.r.t., arrived in the Tees some time ago with a cargo of Scrap from the Far East and the mere fact that it was the large liner it was, meant a slower rate of discharge, higher costs per ton discharged, with consequent inadequacy of existing rates based on a type of scrap carrier far different from the liner. Greater hold depth and freeboard meant a greater distance for the crane sets to travel for each crane load taken from the ship, a liner meant a higher manning scale and, above all, the ship's construction itself introduced further difficulties especially since this was a twin-screw vessel with ditches each side of the tunnel in the after-end of the ship.

ILMENITE

Ilmenite, a commodity used in the manufacture of many products in everyday use, is of growing importance among Teesside seasonal imports from India.

The discharge from ship is accomplished by means of tubs or iron cargo trays, its main physical features from a handling point of view being its similarity to very fine dry sand.

For removing cargoes of Ilmenite from quayside to local works from the port operator's point of view, certain advantages arise from the use of a fleet of lorries as compared with railway wagons. In the first place, there is less congestion of the quay front since the number of lorries used is related to the need of the cranes employed and, therefore, it is the exception to have more than two, or at the most, three lorries awaiting turn. Secondly, unremunerative quayside shunting is eliminated, apart, of course, from the shunting at the end of the shift of the few railway wagons used as a cushion, and the locomotive power released can be made available elsewhere.

From the importer's point of view, he receives his cargo more quickly, his aggregate carriage costs are probably less, taking into account that no packing is required, and he can probably make better use of the stocking ground on account of the greater manœuvrability of the lorry, as compared with a railway wagon, and, of course, the tipping action of the lorry means speedier stocking with little if any labour. Nevertheless, this is no proposal for the use of motor transport generally, in the reception of bulk cargoes from the ship's hold, for delivery to the consignees, but it does show that given suitable conditions, e.g., a relatively short haul and a cargo of high loading capacity, road transport can play an important part in the economical and speedy movement of bulk cargoes.

GENERAL CARGO

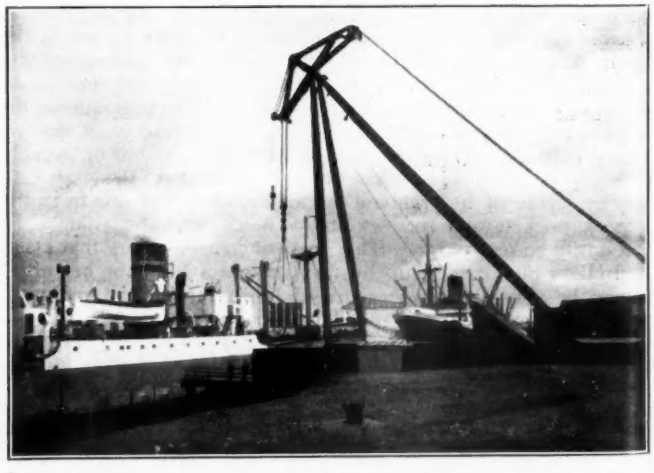
You will have gathered that the Tees is in the nature of a specialist port and that the proportions of cargoes, other than the raw materials of the heavy industries of the locality are relatively small. Nevertheless, the following are a few of the many and various commodities which have arrived by incoming vessels during the past year: Paper, Plywood, Foodstuffs, Sulphite/Rye, Woodflour, Odoriser.

These commodities, of course, have arrived in only small quantities on liner terms, carried by such lines as the Glen and Shire (Holts), Worms & Co. of Rouen, Bergenski Line and Donald Currie & Co., which lines trade regularly to Middlesbrough. Such commodities cannot as a rule be loaded direct to transport at the ship's side primarily on account of two factors, firstly, the authority must hold the goods as agent for the shipowners to enable the latter to exercise his lien for any unpaid freight and other charges on the goods, and, secondly, H.M. Customs must satisfy themselves that the entries and documents deposited with them by the importers or agent relates to the goods actually landed, and that, any necessary import licences or invoices are obtained, any required bond given and any duty paid. These general goods, therefore—and under this heading I am including the majority of packed goods and other articles other than bulk cargoes and not recurring with such frequency as to consider them as regular cargoes—must as a rule be warehoused to wait for Customs clearance and release, to undergo any necessary repair, etc., and be reloaded as soon as possible thereafter.

May I just say a word about "Customs clearance." I hope I have not given you the idea that if goods do not come within this arbitary classification of "General Cargo," H.M. Customs are quite unconcerned and that bulk cargoes, etc., are quite outside their range of interest. All inward cargoes are entered—from a food parcel, weighing a pound or two, to a cargo of Ore of 10,000 tons. The distinction is that Iron Ore, besides being a "free" commodity, that is, free from Duty, comes in such quantities and with such frequency into the river, that it would be obviously uneconomical for a highly-paid official of H.M. Customs to inspect each cargo, when it is virtually available for inspection by anyone looking into the ship's holds as soon as the hatch covers have been removed.

The arrangement that obtains in the Tees is for the Waterguard branch, which, of necessity must board every vessel entering the river to search for contraband throughout the length of the vessel, to act as agent for H.M. Customs in the inspection of the cargo, with the result that clearance of such a cargo is automatic as soon as she commences discharge. As regards other goods, which must undergo special treatment for all inspection to be carried out, such as the opening of a crate or case, these goods are entered in the normal manner at the Custom House and the entry checked and passed, if it is made out in the prescribed manner, any necessary documents produced and any duty paid.

In common with all good accounting systems, the handling and



Shipping Transformer by means of Sheerlegs, Dent's Wharf, Middlesbrough.

The Handling of Import Cargoes—continued

accounting for cash, in this case, duty, is kept entirely separate from the work in connection with the goods themselves. After the entry has been passed, it is handed over to the Landing Officer, who, although still an officer of H.M. Customs, belongs to a department entirely separate from that to which the duty has been paid, and the responsibility of this official is to verify that the goods landed conform to the description given in the Customs Entry. It may be that a different grade of the same commodity calls for a higher rate of duty, that the goods landed require sampling before the correct classification can be ascertained and the correct duty calculated, and it is for this reason that goods, which it was hoped would be in the consignee's possession within forty-eight hours of the discharge of the ship, are not available to him for several days.

For the benefit of those among you whose knowledge of the general practice of port operation makes them shudder at the use of the word " warehouse " when " transit shed " is the obviously correct designation, I make no apology for such use, but I should repeat that the relatively low proportion of such cargoes would never warrant the immobility of sheds at each berth with special shed staff at each.

In my limited experience I have learned, I hope, not to be dogmatic about practices and procedure in this industry and although I have heard it contended by persons of wide experience that without qualifications a transit shed is an essential feature at each and every berth used for general cargo working, in practice I think it is obvious that with about 99% of the traffic going direct from ship to railway wagon or road transport, any shed accommodation on the quay must be more remuneratively employed than merely being available for the small quantities of general cargo arriving. Moreover, any additional handling as is required by the placing into warehouse and loading thereto, in addition to adding to the possibility of pilferage and damage, necessarily adds to the handling costs and consequent costs of the importer, and, therefore, it is, at least in the circumstances with which I am most familiar, a worthwhile aim, when possible, to avoid this second handling and load direct to transport. As I have pointed out above, this is frequently impossible when the goods are for despatch by road.

Time does not permit me to refer to the many other interesting cargoes discharged in Middlesbrough, e.g. bundles of Plywood from France, crates of Hardboard from Scandinavia, Magnesite from Czechoslovakia and even empty boxes—returned from Sweden.

The principal imports of a port do not readily change for the reasons we have seen, namely, that the very reason for those imports is the organisation at and beyond the port, and the industries of the hinterland. With possible trends, therefore, I shall not be so bold as to concern myself, except to say that it does appear that Scrap imports must, within the foreseeable future, assume something more like pre-war proportions, and that Iron Ore cargoes may become more and more confined to the private wharves of the ironfounders.

These then, are a few of the problems encountered by those responsible for the discharge of ships' cargoes in the River Tees. Although other organisations are involved in the turn-round of shipping, the quay or dock authority's is probably the most important role. I suppose that, generally speaking, such problems spring from causes which are not readily, if at all, removable, and an out-and-out solution cannot be obtained. Nevertheless, with an intelligent approach, allied to past experience, the effects can be modified and any conceivable danger and difficulty countered. Generally, this approach and call upon past experience lead to success and ensure a satisfactory operation. If they do not, then failure is not defeat; it is merely getting a little experience.

Mechanisation in United Kingdom Ports

Working Party's Report and Recommendations

As stated in last month's Editorial Comments, the Report to the Minister of Transport by the Working Party on Increased Mechanisation in the United Kingdom Ports, was published towards the end of May (H.M. Stationery Office, price 4d.). The Report was received too late for full details to be included on our June issue, but as the subject is of great importance we now publish the following salient points:

TERMS OF REFERENCE

The Working Party was appointed on 25th March, 1948, and the following terms of reference were adopted:

" To make a comprehensive review of the possibilities of increased mechanisation in the ports of the United Kingdom, with special attention to the handling of timber imports; to make a study of the use of mechanical handling equipment in foreign ports; and to make recommendations in respect of the possibilities of increased mechanisation in the ports of the United Kingdom, including the extent to which the provision of such increased mechanisation will be beneficial to port operations by obtaining a speedier turn-round of shipping, by the more expeditious handling of goods through the ports, and by the more economic use of labour force."

While the main task, however, was to investigate and recommend the improvements which were technically practicable, it was not the function of the Working Party to make specific recommendations on the industrial effect of any increased mechanisation recommended by them beyond calling attention to the more economic use of the labour force which would result.

NAMES OF PORTS VISITED

The following ports were visited: Bristol, Cardiff, Glasgow, Grangemouth, Grimsby and Immingham, Hartlepools, Hull, Leith, Liverpool and Birkenhead, London, Manchester, Middlesbrough, Newcastle, Newport, Southampton and Swansea. Two Continental Ports, Antwerp and Rotterdam were also visited.

DEVELOPMENT AND PRESENT USE OF MECHANICAL AIDS

With regard to the development and present use of machinery in the work of cargo handling in the ports, the Report states that with the advance of engineering science the operation of loading and discharging ships has had recourse to a variety of machines to suit particular tasks, commencing with small hand-operated appliances until to-day the variety of equipment which is available to the industry is of a considerable magnitude. At the present time the ports of this country are all equipped with mechanical aids to a varying degree, but it is no unusual sight to see modern equipment working alongside the most out-of-date appliances, or the work being done entirely by hand.

In certain of our ports mechanical aids of the most modern type are in use for carrying out various tasks, and there is little, if any, recommendation this Working Party could make to improve upon their technical efficiency. Such instances are, however, exceptional, and in many of the ports man-handling of cargo is still the principal method used. It must be remembered that in certain of our ports there are quays, transit sheds, and warehouses which were constructed a century or more ago, when the size and type of ship as well as of cargo were vastly different from those of to-day. We appreciate that the construction and lay-out of these facilities do not lend themselves to the full use of modern handling machinery. To the extent that such places are still in use, we are doubtful if any other methods of handling goods than those already being employed could be introduced to advantage. In certain areas where ports have been constantly busy over many years, increasing trade has made it possible to develop in the direction of modern equipment, but in others recessions in trade, and other reasons have precluded capital development of a substantial nature. We have found that as well as the need for extending the scope or taking advantage of new designs and types of mechanical equipment, there is the need to replace existing and old-fashioned equipment by more modern, faster working machines but of the same type in principle; this is particularly so in the case of cranes.

Mechanisation in United Kingdom Ports—continued

Further, there is a need before mechanical equipment can be introduced, for reconstruction of quays, transit sheds and warehouses destroyed during the war. It is appreciated that where works of a major nature have to be undertaken, full advantage cannot be secured from the use of increased mechanisation for the time being, and only a measure of improvisation is possible. It is most important, however, that in the planning of new quays and sheds, consideration should be given to see that traffic may be handled with the utmost efficiency, and, in particular, regard should be given to the speed of despatch at the lowest possible cost.

PHYSICAL CONDITIONS AT THE PORTS

In the planning stage, the Report continues, there will be many considerations which will have to be taken into account, but there are certain features which might be mentioned as a general guide to those whose responsibility is to undertake this work, and these are as set out below:

(a) It is essential that the quay surfaces and shed floors should be such as to ensure that mobile equipment is not subjected to undue mechanical stress involving excessive wear and tear, and also that any type of equipment can be handled with safety.

(b) There should be the fullest possible freedom of movement of mechanical equipment on the quays and in the sheds, and therefore such movement should not be excessively handicapped by the presence of unnecessary hindrances on the quays or too many pillars in the sheds.

(c) The doors of the sheds should be of sufficient width and height to allow easy ingress and egress of movable equipment, particularly as far as concerns mobile cranes.

(d) The lighting on the quays and in the sheds should be sufficient, and placed conveniently for the operation of mobile equipment.

(e) The surfaces of any roadways at the back of the sheds required to be used for piling or stacking of commodities which can be stored in the open should be suitable for the easy movement of mobile equipment.

(f) Any railway lines on the quays, in the sheds, or on the roadways should not be proud of the surface, or alternatively, level cross-overs should be provided to the maximum extent.

(g) In planning sheds and warehouses having upper floors, consideration should be given to the desirability of constructing the upper floors with sufficient strength and headroom to permit mechanical appliances to operate and pile goods to the best advantage, and of the provision of lifts capable of conveying such equipment from floor to floor.

CARGO HANDLING

As far as the handling of bulk materials is concerned there is little we have to say on the actual types of equipment to be used for these are well known to the industry, except that in certain ports there is not enough of it, or not enough use made of what is available. This particularly applies to grain and oil seed discharge, and at the iron-ore ports where old-fashioned cranes should be superseded by modern, fast working cranes of a higher capacity, or better still, in certain instances by transporter equipment similar to that which has recently been put into operation at Middlesbrough and Antwerp.

The question of general cargo handling is a more difficult problem. A great variety of goods has to be handled and the physical working conditions differ considerably between port and port so that it would not be practical to attempt to set out a standard method of working. Over the past few years, apart from technical development in cargo handling cranes which are a feature of most of our major ports, there has been developed a wide range of portable appliances, such as electric mobile trucks and mobile diesel cranes, and, perhaps most important of all, the fork lift truck. This machine has undoubtedly great possibilities for the rapid and efficient handling of all types of cased and packaged goods, both in warehouses and transit sheds and in the holds of ships. Its many advantages are fully appreciated by shipowners, port employers and dockers. The extent to which this machine is already in use in our ports is not very great.

NEW MECHANICAL EQUIPMENT AT THE PORTS

It must be appreciated in reviewing the state of machinery in our ports that insufficient new equipment, other than mobile equipment, has been available to the industry since 1939 and during the years of the war normal care and maintenance which would have been undertaken had to be sacrificed because of the urgency of the times. Since the war the amount of new equipment port authorities and others have been able to acquire and replace that which was worn out, has been limited by the capacity of the manufacturers to supply.

MECHANICAL EQUIPMENT ON THE SHIP

In our visits to the ports and our examination of the existing conditions for cargo handling, we have also examined the equipment which is to be found on the ship itself and the difficulties which are experienced in loading and discharging certain types of ships because of their construction. It has been made quite clear to us that if full advantage is to be taken of modern appliances. when and where available, to handle cargo on the quays and in the sheds, consideration should be given by naval architects and ship constructors to developments in cargo handling gear, such as improved winches or the installation of luffing cranes on the ship and to the construction of cargo-carrying spaces in order that portable appliances, such as fork lift trucks, mechanical shovels, gravity or mechanical rollers, or elevators can be employed in the vessel to assist in loading and discharging cargo. We feel that much can be done in this direction, due regard being paid to the nature of the trade in which the ship is to be employed.

POINTS OF VIEW OF WORKPEOPLE AND OF EMPLOYERS

In our discussions with the work people's representatives we have met with a ready and frank appreciation of the need, not only to use an increasing amount of machinery to replace the more arduous methods of work which are still to be found in our ports, but in order that the most efficient and speediest methods of cargo handling should be employed so that our ports and shipping may be competitive with those of the foreigner, particularly with regard to trans-shipment cargo. They feel, nevertheless, that the financial advantages which may result from any new arrangements which may be finally agreed within the industry for the use of mechanical aids should be shared between the employers and the work people. We have found little evidence of appreciation by the work people of the further point that the increased use of machinery is required, not for financial gain to the employers or employees, but rather to see that an economy is made which will eventually affect the fortunes of the nation, and the individual consumer of the goods they handle by a reduction in freight rates and a general lowering of handling charges.

At the same time, however, the work-people's representatives have pointed out to us their very natural fear that an increased use of mechanical equipment, involving a reduction in the number of men employed, or even a reduction in the manning scales on existing machinery, will bring about unemployment in the industry. Recollections of the years before the war when the port labour industry was on a casual basis and unemployment was high obviously remain very vividly in the minds of the work people and their representatives. Difficulties which port employers and others have had in securing more practical and economical arrangements in the use of mechanical handling equipment are, we believe, very largely the result of these experiences. There is an inherent fear among both the work people and their representatives that the use of machinery is aimed directly if not exclusively at them.

In our discussions with port employers concerned with the problems of cargo handling, we have found in almost every case a ready appreciation of the need to use the most efficient machines for these tasks. In many instances new equipment is already in operation and almost without exception we were shown development plans taking full account of the use wherever possible of mechanical handling equipment. It has been repeatedly stated to us that in their opinion before capital expenditure of a considerable magnitude is undertaken, labour costs must be reduced to justify

Mechanisation in United Kingdom Ports—continued

the venture. It has been claimed that with existing mechanical equipment the cost of operation is at the present time too high, and further, than an adjustment in manning scales to avoid wasteful use of labour, and to make the employment of such machines economical in the widest sense, and to justify the extension of mechanical equipment generally could easily be effected without undue hardship. It has been pointed out to us that at some ports there exists a division of responsibility for the unloading or loading of vessels which makes it difficult to obtain the full advantages which should accrue from the introduction of mechanical handling machinery. We refer, in particular, to arrangements which provide for one authority undertaking the work on the quay and another carrying out the work within the ship. With the introduction of machinery it would, in certain cases, be possible to reduce the number of men employed on the quay, but make it necessary to increase the number of men within the ship. To this extent the benefits resulting are likely to be disproportionate. It was suggested to us that the placing of the responsibility for the complete operation of loading or unloading under one authority would assist in the negotiations for revised manning scales and be conducive to obtaining the full benefits of mechanisation.

The Report ends with the following unanimous conclusions and recommendations:

CONCLUSIONS

(a) There is a wide field for the increased employment of mechanical aids in the port industry, if every advantage is taken of facilities such equipment can offer for increasing the rate of work, economising in the use of man-power, and reducing the physical effort required from the men engaged on cargo-handling operations.

(b) No large-scale development in the use of mechanical handling equipment with the resultant advantages referred to in Conclusion (a) is likely to take place in the port industry unless and until the problem of the efficient and economic use of both existing and future equipment has been settled on a national basis by both sides of the industry. In that connection it seems to us essential that some steps should be taken to allay the fears of the work people as to the possibility of unemployment in the industry increasing as the amount of machinery used is extended.

(c) There exists at the present time in the ports of the United Kingdom many practices prejudicial to the use and extension of the use of mechanical equipment which in many cases have been brought about as the result of conditions in the port industry in the days before decasualisation of the dock labour. Largely they are regarded by the men as a protection against unemployment. These practices have the effect of making the cost of various port operations uneconomic and uncompetitive. Further, we believe that they must inevitably add a charge to many commodities passing through the ports for which there is no justification in the public interest, and which must eventually be the cause of the very condition they have been brought about to prevent.

(d) In future planning of reconstruction and development of port facilities there is a clear need for consultation by the port authority or other sponsoring body with port operators, shipowners and the work people's representatives. At the same time opportunity should be taken of having expert advice from the designers and manufacturers of the machinery it is proposed to use. In this way co-operation between all interests could, we believe, be obtained not only to ensure the best results but also to engender in those concerned a fuller sense of responsibility and understanding of the many problems affecting the industry.

(e) In the handling of general cargo in warehouse, shed, on the quay and in the ship's hold we are convinced that the fork lift truck offers the greatest scope for obtaining a better despatch of the ship and for the lowering of transportation costs in the ports. Together with other mobile equipment to suit particular commodities, this machine will, we believe, if used to its full advantage in every direction, go a long way to achieving the three main objectives set out in our terms of reference.

(f) There is considerable scope for shipowners when contemplating the construction of new tonnage to plan in conjunction with their naval architects and ship constructors the lay-out of holds, 'tween decks and other cargo-carrying space to suit the use of mechanical handling plant. In addition we think increased consideration to the design and lay-out of derricks and/or cranes as well as the design of hatch covers must be given with advantage. If the work on the quay is to be speeded up it is clear to us that the facilities in the ship call for improvement.

(g) There is a lack in many of our ports of up-to-date bulk handling equipment, particularly for the efficient and rapid discharge of grain, oil seeds and iron ore. We have been particularly struck by the paucity of such equipment at certain of our ports in comparison with that which we have observed in the ports of Rotterdam and Antwerp.

RECOMMENDATIONS

(1) The National Joint Council for the Port Transport Industry be requested to take such steps as may be necessary to secure the full implementation of the principles of Clause 10 (Mechanical Appliances) of the National Agreement dated 9th December, 1931.

(2) Having regard to the importance which we attach to Conclusion (b) of this Report we recommend that a national survey be undertaken of the possible effect on the dock labour force as a whole on the assumption that existing mechanical aids are employed to their fullest and most economical extent with manning scales taking every advantage which such equipment offers. Further, we recommend that the survey should take account, where possible, of all instances where mechanical aids might be introduced in the immediate future with advantage. Only by a method such as this will it be possible to judge the extent to which the men's fear of redundancy is a real factor with which the industry has to contend.

(3) The National Joint Council for the Port Transport Industry should be invited by the Minister of Transport to undertake forthwith the national survey recommended in (2) above by establishing at the ports special local joint committees consisting of equal representation of port employers and workpeople to undertake the local surveys and to report the results to the National Joint Council for the Port Transport Industry. We further recommend that the special local joint committees referred to above should have among their members an engineer, or engineers, qualified to advise on the technical aspects and possibilities of all equipment under discussion.

(4) In the consideration by the special local joint committees referred to in Recommendation (3) of any revision of manning scales, the operations on the ship, on the quay and in the shed should be taken as an integral whole, and it should be assumed that there would be the greatest possible flexibility in the development of dock labour not only in the adjustment of gang manning as between the shore and the ship, but also between gang and gang.

(5) The National Joint Council for the Port Transport Industry should be requested to give immediate consideration to the results of the local surveys referred to in Recommendation (3) above and in the light of its findings determine the basis for the general introduction and use of mechanical aids.

(6) To the extent to which any dock labour is displaced by the proper use of mechanical aids, consideration might well be given to the making of allowances to elderly dockers who are prepared to retire. To the extent to which such proposal, together with normal wastage, is insufficient to provide for any redundancy within the industry which may be caused by the full and more economic use of machinery, a temporary reduction in the degree of recruitment to the industry might be justified.

(7) A study should be made at an early date of the equipment used and the methods of work employed in the major ports of the United States and Canada.

New Marine Radio System

Description of Installation at the Port of Liverpool

ON Thursday, June 1st, a new marine radio system was formally handed over to the Chairman of the Marine Committee of the Mersey Docks and Harbour Board, Mr. Charles McVey, by Air Vice Marshal O. G. Lywood, C.B., C.B.E., Director of Automatic Telephone & Electric Co., Ltd., and their associated company, British Telecommunications Research, Ltd., who, with Radio Gramophone Development Co., Ltd., have been responsible respectively for the design and manufacture of the equipment. The inaugural ceremony took place on board s.s. "Galatea", the Board's own yacht, and after the equipment had been handed over, at Crosby Light, the opportunity was taken to demonstrate every phase of its working. The "Galatea" then steamed down the Crosby Channel and entered the Gladstone Dock, where the passengers disembarked and inspected the equipment in the Port Radar Station.

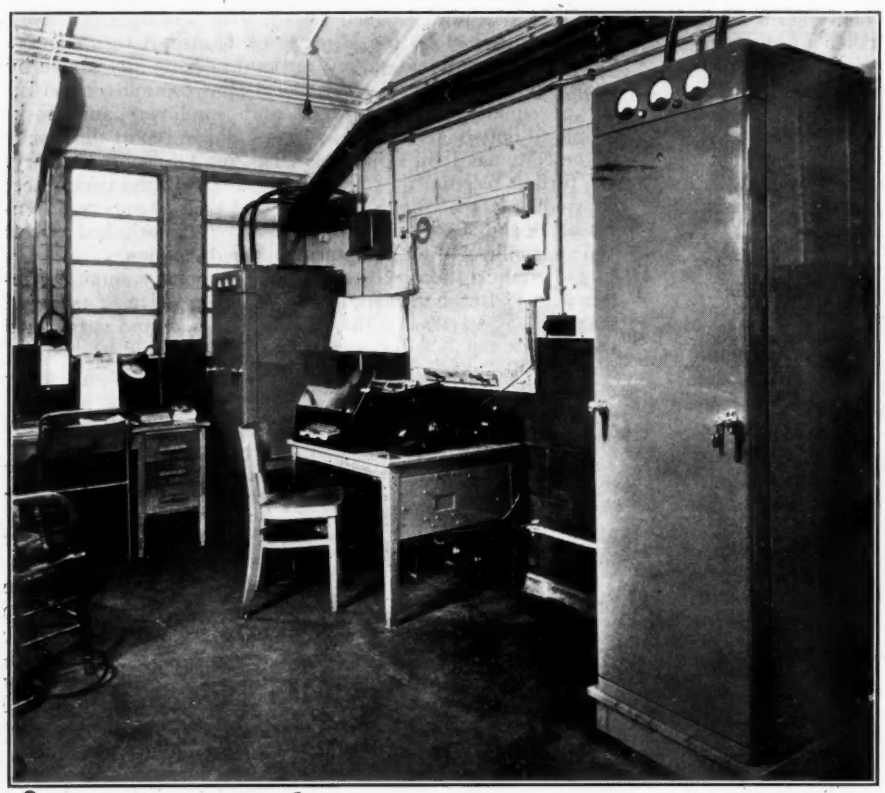
The passage of the "Galatea" afforded a practical demonstration of the greatly improved communication facilities being extended to ships of all tonnages using the port. For the background to these facilities, it is necessary briefly to recount the circumstances which led originally to their earlier adoption in a much less refined form.

During the war years, convoys of as many as 60 vessels would arrive on one tide, and the problem which had always faced Port Authorities in the past, particularly those whose harbours are tidal, of regulating vessels into the docks, became very acute. The existing methods of communication—Aldis lamps, semaphore, whistles and tug boats—proved inadequate and it was decided that the only satisfactory solution was radio telephony; but radio sets were, in those days, unobtainable in the open market. However, the Ministry of Transport and the War Office came to their aid and loaned them a number of army sets, which proved, in the radio conditions which then prevailed, extremely satisfactory and of inestimable value to those responsible for the docking of vessels in the port.

The opening of the new Liverpool Radar Station in the post-war years, and the very much wider scope which it afforded for assisting vessels approaching the river entrance, showed that sets of this type had considerable limitations. Nevertheless, a war-time exigency had become in the eyes of the Mersey Docks and Harbour Board a peace-time necessity, and a rigorous specification was therefore drafted for the guidance of those British radio manufacturers who were in a position to develop suitable equipment to operate in the permissible frequency band. The main requirements stipulated were that satisfactory communications should be maintained at ranges up to 25 miles; that the mobile sets should be readily portable, not exceeding 20 lbs. in weight; and that they should give a choice of sufficient channels to enable pilots to communicate with the Radar Station and the principal dock entrances.

After exhaustive trials of various sets submitted, the contract for 150 portable transmitter-receivers and 10 shore stations was awarded to British Telecommunications Research, Ltd. It had been decided that the equipment should be amplitude-modulated and that both transmitters and receivers should be crystal controlled, and to meet the various requirements of the specification mentioned above, it was necessary to make use of six radio frequency channels within the internationally agreed band which had been licensed by the British Post Office for harbour communications in the United Kingdom.

These channels were accordingly allocated, two for navigational aid and harbour supervision, and four for communications in respect of docking. The two frequencies used for navigational and harbour supervision are Channel 1 and Channel 2, and the shore station equipment for these channels is located at Port Radar. The other four frequencies, viz., Channels 3—6, are shared between nine dock stations, each of which has individual shore station equipment. The division is so arranged that docks the farthest distances apart share channels, and a code calling system is used, which permits the portable sets to call the required shore station.



The Operations room at Port Radar showing both Channel 1 and Channel 2 Shore Station Equipment.

As stated, it was considered of vital importance that the range of the equipment should be up to 25 miles, though, in point of fact, this in practice applies only to Channel 1, and is catered for by the shore station aerial at Port Radar, which is 100 feet above sea level. Communication on Channel 2 is only required over a distance of 12 miles, and the second aerial at Port Radar has been designed accordingly. Communication on the dock station channels has not to exceed 8 miles, and suitable aerials have been erected for this range.

The third major requirement, as to maximum weight of the portable set, was largely the factor which ruled out duplex working in favour of two frequency simplex. The former would have possessed advantages, but would have involved extra equipment, and, in having to work both transmitter and receiver together, would have entailed having larger capacity and correspondingly heavier batteries.

New Marine Radio System—continued

Routine Service

At four-hourly intervals day and night, the radar equipment is switched on and the positions of all vessels in the seaward direction, both under way and at anchor, are transmitted over Channel 1 for the benefit of any ship's master who may wish to plot the information. This is then followed by similar information being given over Channel 2 to vessels which may be needing it in the river area. Following this disposition statement, local weather conditions are transmitted over both channels, together with any local navigation warnings.

At all times between these regular services, communications may be established over both Channels 1 and 2 with vessels entering or departing from the port. The portable sets are taken aboard ships by the pilots at their boarding stations which, inward bound, are off Point Lynas, or at the Bar Light Ship. As soon as inward-bound ships arrive within the port communications area, they call up the operation room at Port Radar over Channel 1 and give their name, draught and expected time of arrival at the mouth of the river or at the Princes Landing Stage, as may be appropriate. This information is passed by land-line to the departments concerned. When the vessels come within range of the dock station equipment, the pilot can then communicate direct with the dock master for information as to the particular berth the ship is to occupy, which by then will have been decided.

Under adverse weather conditions, the combined radio and radar equipment operates to enable vessels to enter and traverse the Crosby Channel and proceed to anchorages in the river or directly into dock, as may be required. Likewise, vessels leaving port may seek and obtain information which will give them safe passage to the Irish Sea. In circumstances of particularly heavy traffic on Channel 1, vessels within the shorter range of Channel 2 may be requested to use this channel to free the longer range channel for communications with vessels further away from the shore station.

Technical Design

The major problem in the Mersey Docks and Harbour Board scheme was to obtain communication over a distance of 23 sea miles on Channel 1 at the frequency employed. This difficulty was further increased by the size and weight limitations of the pilot's hand portable equipment, restricting the transmission power to not more than ¼ watt and the receiver sensitivity to approximately 15 microvolts. Added to this, the cost of building a high tower to carry the shore station aerial had to be kept within reasonable bounds.

The angular bearings and distances seawards in respect to Port Radar at the required range are shown in Fig. 1, and preliminary calculations were made to determine the approximate field strength which could be expected over a distance of 23 sea miles at the land station. Fig. 2 shows the positions of the docks at which equipment is housed.

Preliminary calculations were made to determine the required power of the shore station equipment to obtain communication over the same range with a portable receiver having the sensitivity previously mentioned.

For this purpose, reference was made to a paper by T. L. Eckersley (Short Wave Reflection and Deflection, Journal I.E.E., Vol. 8, page 286, 1937). The designers employed in their calculations 150 Mc/s over sea, and by fixing the conditions stated below, it was possible to produce a graph which in practice was found very close to practical results. The conditions of calculation were as follows:—

(1) Shore station aerial height 100-ft. above sea level (aerial tower + height of sea wall).

(2) Aerial height of portable set above sea level – zero (as this was a variable quantity, it was fixed at sea level).

(3) Aerial power of portable equipment ¼ watt.

(4) Maximum sensitivity at the shore receiver for good signal to noise 2 microvolts.

(5) Single dipole used for reference.

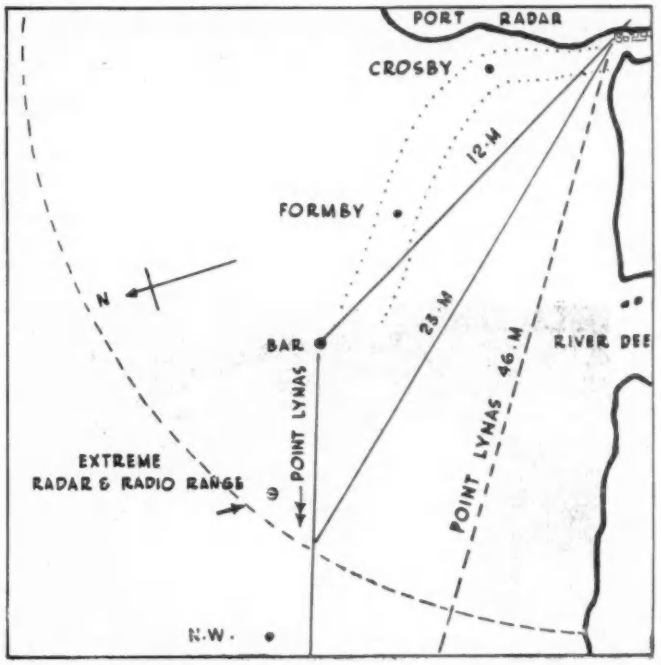


Fig. 1. The approach channel to the River Mersey showing the communication distance and Radar Range in respect to "Port Radar."

Somewhat higher aerial powers at the land station were actually obtainable than were originally thought to be possible (i.e., 45 watts) and the portable set's sensitivity was also improved. This produced a slight unbalance in signal levels biased in favour of shore to ship, but this was considered to be a slight advantage when operating in bad weather and high winds.

It was decided that the aerial to be employed should be a 32-element centre fed beam with a meshed metal reflector. This aerial is mounted on an 80-ft. high tower situated approximately 50-ft. from Port Radar control room.

Channel 2 at Port Radar, which requires an operational range of 14 sea miles, employs a Yagi type aerial with one driven element and four directors. This aerial is mounted on a metal pole extending 20-ft. above the beam aerial on the same tower. At this height (i.e., 100-ft. + sea wall) it is a visual distance to the Bar Light Ship, thus eliminating the requirement for a high gain aerial array.

As communication is required on both the seaward approaches and the river, it necessitates the use of four aerials, two looking seaward on Channels 1 and 6, and two looking riverward on the same channels.

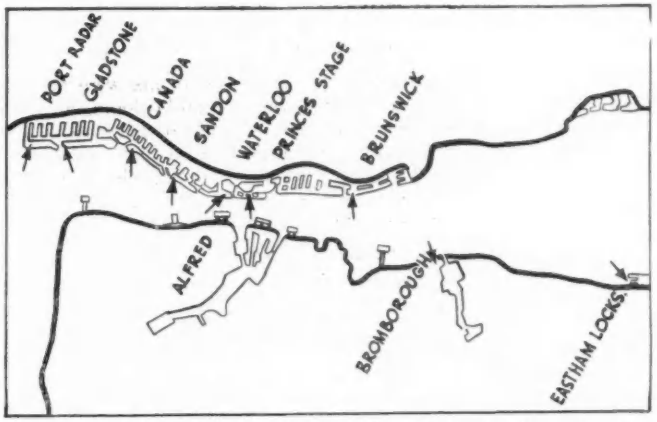


Fig. 2. The Dock area of the River Mersey showing the points at which shore equipment is installed.

New Marine Radio System—continued

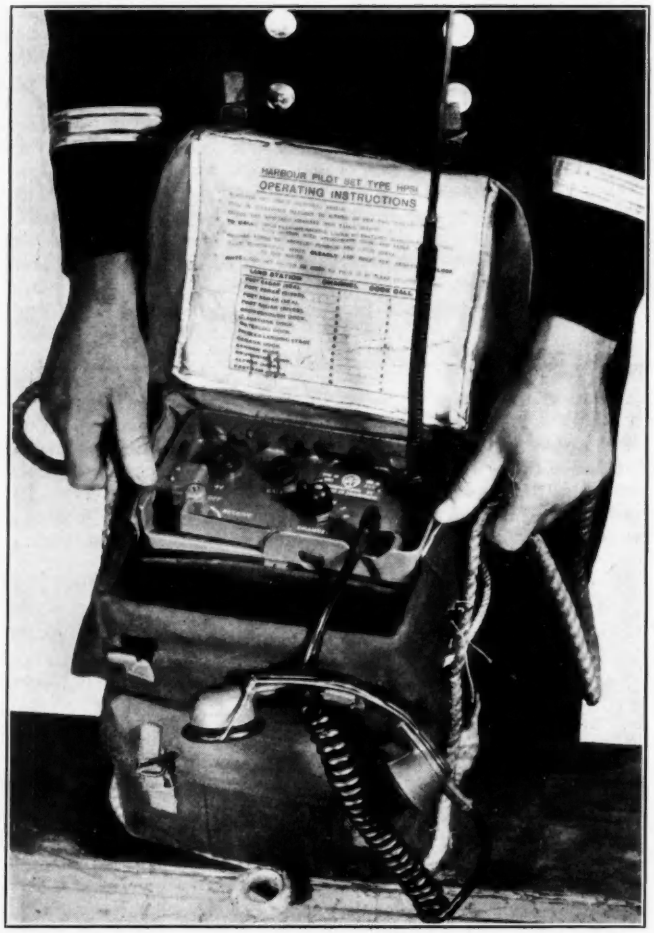
Two receivers are employed per channel and are connected to their respective aerials. This arrangement permits "listening out" on both channels and in both directions simultaneously.

One transmitter unit only is employed per channel, and the operator, by the movement of a switch, can select the direction of transmission.

MECHANICAL DESIGN.

Land Station Equipment

Emphasis has been laid earlier on the major requirements of the installation, but coupled with these were a number of other factors which had to be taken into consideration when the



The Six-channel Portable set used by Ships' Pilots to communicate with Port Radar and any one of nine Dock Stations.

apparatus was being designed. These requirements were met by fitting the equipment in cupboards with lockable doors, and the various units are arranged to withdraw on telescopic runners for inspection. Each unit, with the exception of the transmitter power unit, is divided into two or more sub-units, which allows a semi-skilled engineer to service the unit quickly by substitution. Spare units for this purpose are stored at the maintenance depot.

The Portable Set

As designed, the equipment is housed in a hermetically sealed case, rain and water proof, and fitted to the top of the case are an "on/off" switch combined with the transmitter receiver switch, spring loaded so that it cannot be left on when not in use, a six-way channel switch, a signal press-button and the aerial plug. Together with non-spill chargeable accumulators and collapsible aerial, the whole of the equipment is protected by a padded canvas case fitted with rope loops, and weighs a fraction less than 20 lbs.

The New Harbours of Aruba and Curacao

A Review of the Projects at Oranjestad and Schottegat and the Special Types of Concrete and Steel Cofferdam Walls adopted.

By J. F. GROOTE.

(Continued from page 45)

CATHODIC PROTECTION OF THE STEEL SHEET PILING

Investigations made in Curacao concerning the corrosion of steel sheet piling gave contradictory results.

A 19-year old Larssen-sheet piling, extracted from the St. Annabay, showed only faint traces of corrosion under water. In the water surrounding it, no acorn-shells were found, which are one of the chief causes of corrosion in sea-water. This absence is due to the oil which is found on the surface and in the water. If circumstances were the same all over the harbour, the life of the sheet piling could be estimated safely at more than 70 years.

Experiments made by the C.P.I.M. in other places in the Schottegat, however, showed less favourable results. They indicated that we can count on a 40-year old life of the sheet piling, even taking into consideration that there will hardly be any wave-action in the new harbour. How favourable the first mentioned circumstances were, was proved by the serious corrosion of 12-year old sheet piling near the floating bridge, which was exposed to the direct wave-action from the sea.

A duration of life of 40 years was considered insufficient and it was contemplated in what way the steel could be protected efficiently.

A substantial coat of paint applied all over the structure will lengthen the life of it, but it is not possible to make such a protection without risk of defects, fissures or damage. Small parts of the wall will remain highly exposed to deterioration by corrosion, and the question was raised as to how to protect these parts also. In this respect no big risks can be run in Curacao, because we have always to bear in mind that our prosperity is unstable and there may come a time when it will be difficult to find money for extensive maintenance works.

We had heard that pipelines in the oilfields often were protected by a relatively new system. In co-operation with Dr. Sj. van de Baan, corrosion expert of the C.P.I.M., we made ourselves acquainted with it and soon it was clear to us that Cathodic protection had passed the experimental phase a long time ago.

In the beginning, I must confess, we had to fight a certain reluctance, but the more we mastered the details the more it appeared to us that this might be the same experience several physicians had in the occupied zone after the war with respect to penicillin and sulfa products.

In theory the Cathodic protection is a very simple one, which is to create circumstances under which the metal to be protected is negative with respect to its surroundings, whether it is water or soil, by causing an electric current to flow from the surroundings to the protected metal. Without going into the matter thoroughly, which is outside my sphere, I understand that corrosion is caused by small electric currents leaving the surface of the metal.

These currents cannot exist when the metal is covered with an insulating layer of if an electric current flows towards the metal, but this simple principle can have complicated methods of application.

The current necessary to decrease the potential of the protected structure by 0.2 to 0.5 volt, which is usually sufficient, can be generated in different ways.

If a reliable electric system is at hand, then the application of rectifiers is the most simple solution; if not, one can choose between a power-plant or galvanic cells. The latter, which in the U.S.A. are on the market, are suitable when the consumption of current is small.

In all cases care should be taken that the whole steel structure is connected in an electrically satisfactory way with the negative

The New Harbours of Aruba and Curacao—continued

pole of the source of the current, which so becomes the cathode of the system, while the anode is composed of scrap iron buried in one or more places. Simply speaking, one might say that corrosion will concentrate, to a marked degree, in the steel anode; renewal of which will be necessary after a number of years. We estimate this period to be 10 to 20 years, and this will be taken into consideration during the construction.

It should be added that replacement can be avoided by using graphite anodes. This introduces, however, other phenomena (among others, an increase of consumption of current), discussion of which I must leave to specialists, and the choice of the location of the anodes is, of course, also their responsibility. We were favoured by a visit from one of the pioneers, Mr. Starr Thayer, member of the National Association of Corrosion Engineers at Houston. In 1932, he applied this protection for the first time to protect buried metal. He wrote to me, as follows:—

> " . . . Since that time it (Cathodic protection) has grown to quite a large industry. Almost all pipe lines use the method and many engineers are now entirely engaged in this work. Most of the applications of this protection have been on pipe lines. However, it has been used with equal success on sheet piles, such as this structure, on tank bottoms, on water and oil well casings, and many other types of structures. This protection has long since ceased to be just a theory. It has been demonstrated repeatedly that it absolutely stops corrosion when properly applied."

From this it will be clear that unpainted steel structures can be protected electrically, provided they are situated under water or in moist earth, for the current then flows to the entire steel surface.

If paint or other insulation materials are expensive and current is cheap, the Cathodic system alone might serve the purpose at Curacao.

Thayer calculated the cost under different circumstances and came to the conclusion that in our case it would pay to first coat the steel with the best material. The cost of a triple treatment of the steel with Bitumastic was about Cfl. 150,000, while that of the complete Cathodic protection (including the fixing of the electric wiring) would amount to Cfl. 40,000. The annual charges for current would be about Cfl. 2,500.

By omitting the insulating paint coating, the electric installation not only became bigger and more expensive. but what is more important, the annual cost for current would become ten times more. After comparison of all the figures, the best quality material for first coating the steel was chosen.

Further particulars on Cathodic Protection can be found in the following list of literature:—

(1) "The Corrosion Handbook," by Herbert H. Uhlig. New York, John Wiley & Sons, Inc.; London, Chapman & Hall, Limited.

(2) "Control of Pipeline Corrosion," by Co., Mudd. National Association of Corrosion Engineers, Houston.

(3) "Corrosion," a monthly periodical, in which, among others, applications of the Cathodic Protection are given. Published by the National Association of Corrosion Engineers, Houston.

BASIS OF DESIGN AND CALCULATION OF THE CELLULAR COFFERDAM TYPE OF QUAY WALL

By J. C. DUDOK.

The calculations for stability were made according to the method given by Prof. J. Verdeyen of the Brussels University and published in the technical monthly, " l'Ossature Metallique " (No. 2) of February, 1948.

Before going over the calculation of the cellular quay wall itself, it might be useful to describe the general principles involved, considering this method of cellular construction as withstanding only water pressure at its rear (see Fig. 6).

The external forces on the structure are the weight of the internal fill P and water pressure H.

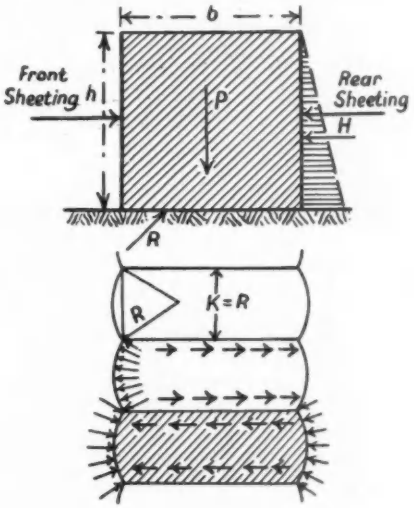
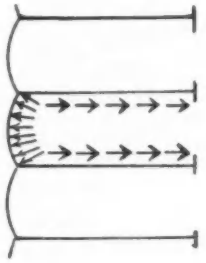


Fig. 6 (left) and Fig. 7 (right)



The row of cells can be contemplated now as a retaining wall of which the stability is assured, if in every horizontal cross-section only compression occurs, i.e., when the resultant of H and P crosses the bottom-layer within the core. Subject to this, a width is fixed, whilst the security against shear follows from

$ug = \frac{P \operatorname{tg} \gamma}{H}$ which γ is the angle of natural slope of the fill.

In calculating the internal stability of the fill, the front sheeting can be considered as only flexibly retaining the fill on which its active pressure acts as a resultant load. As a result of the deformation of the sheeting, the distribution of the pressure, however, is not linear as it would have been according to the theory of Coulomb, but it is greater at the top and lower in the middle. Tests have proved that the resultant of this pressure acts at about half of the height. The sheeting transfers the radial ground-pressure to the bulkheads, so that a radial tension comes into being.

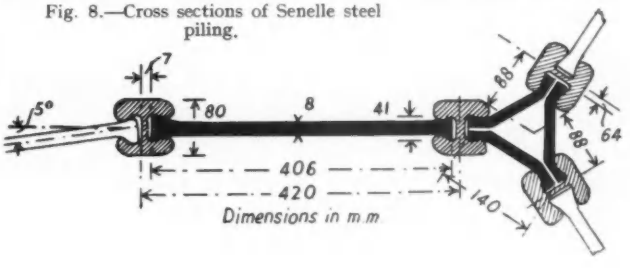
The deflection that is caused by the deformation of the sheeting in front has its maximum value at between a quarter and a half of the height; the longitudinal stresses caused by the deformation and the tangential tension form together a stress which, however, will not be dangerous.

The bulkheads connect the front and rear sheeting and, according to Verdeyen, the most economical solution will be obtained if the anchoring of the front sheeting by means of the bulkheads is entirely attained by the friction between the fill and the bulkhead. In this case the bulkhead does not cause any stress on the rear sheeting, which sheeting only serves to make the fill watertight and is pressed by the water against the fill, so that no stresses occur.

The fill itself is compressed by the water pressure in such a way that only a horizontal shear develops, which is resisted by the increasing earth pressure.

Upon the application of an external load, the pressure which the rear sheeting exercises on the interior fill is the active pressure

Fig. 8.—Cross sections of Senelle steel piling.



The New Harbours of Aruba and Curacao—continued

Ea, so that with a total frictional resistance T, and a water pressure H, the safety factor will be:

$$\gamma v = \frac{T + Ea}{H}$$

(a) It is assumed in the above described cofferdam that on the front sheeting only the active ground-pressure from the fill acts, so that drainage of the fill is strictly necessary. This drainage can be obtained in most cases very simply by making holes at the bottom of the front sheeting, which will give the seepage water a possibility to flow out.

Verdeyen advises incompressible material for the fill, as otherwise excessive deformation can decrease the water-tightening action of the rear sheeting, because more space will be available in the locks of the sheeting.

The depth of the sheeting has to be calculated in such a way that the passive ground-pressure outside resists the active pressure caused by the fill.

(b) In the case of a structure working solely as an earth retaining dam, it will be clear according to the above that the rear sheeting can be done away with (Fig. 7).

If the bulkheads are of such a length that the anchoring of the front sheeting is sufficiently assured by the friction, the rear end of them need not be connected to anchorage piles.

(c) If an earth retaining structure is constructed in a way that the back filling of the area behind has been done first, the cells being constructed by degrees—a working method which, although avoiding the costly and time-wasting interior filling of the cells, gives, however, difficulties in connection with the anchor sheeting (mentioned under (b)).

In this case it will only be possible to build complete cells including rear sheeting. The method of calculation as indicated in the introduction does not lead in this case to economical results, as the rear sheeting is not necessary for its water-tightening tasks, serving only to increase the security. When, however, the distance of the bulkheads—therefore, also the radius—is increased, the rear sheeting plays an active part, as the bulkheads will transfer in this case part of the tension of the front sheeting to the rear. Also the rear sheeting acts against the fill with a pressure equal to the load on the bulkheads and the external active pressure, so that the stability of the fill has to be examined.

For a cellular type quay wall sustaining water on the front, this method of design has to be followed, but here the allowable load from the fill will be larger in view of the external pressure. Also in this case a slight tension in the rear sheeting not only seems allowable, but even favourable as it increases the water-tightening action.

In the calculations the increase in surface friction due to the locks of the sheeting was neglected. The determination of this influence at the right value being only possible by study based on model tests; but in any case, the factor of safety of stability of the construction will be increased.

The complete calculations for external equilibrium, sliding, toe pressure, etc., are not reproduced here, they are given in full in "De Ingenieur," No. 19, 1949. Finally, Fig. No. 8 gives the section of Senelle sheet piling, the lock and the triangular pile of a thickness of 8 m.m. In the normal sections Nos. 10 and 12, the thickness of the sheeting is 10 and 12 m.m. respectively, whereas the other dimensions correspond with those of the No. 8 section. The safe horizontal tensile load on the piling is the same for all sections, as this is determined by the allowable stress in the locks.

COSTS OF WORKS

From the foregoing it transpires that the development of the entire project for Aruba has taken place in an unusual way, which was mainly due to circumstances arising from the fact that before requirements and suggestions had been sufficiently resolved, the work had nevertheless to be put into immediate execution. Even now the extent of the work to be carried out is not fully ascertained, not only because, as has been mentioned, the length of the quay wall has not been determined, but also because the number and size of sheds will, as is to be expected, have to be adapted according to need. Whilst local traffic is not considerable, it cannot yet be foreseen to what extent the transit and tourist traffic will grow, for this is indeed what Aruba hopes to attract with its harbour.

Under the circumstances, a complete statement of costs cannot yet be drawn up. In the figures mentioned below, the wall along the Western basin is not included, nor is the completion of the pier, but I have no doubt that should further credits be needed, these will be forthcoming.

The cost of the works put out to contract remained within the estimate, although in the following summary the original figure for Curacao has been maintained by increasing "various unforeseen costs".

	Curacao. Fl.	Aruba. Fl.
Dredging	4,100,000	3,200,000
Quays	4,350,000	3,185,000
Buildings, sheds	2,420,000	720,000
Rolling Stock	500,000	100,000
Tugs	230,000	——
Sites, roads	1,150,000	455,000
Fishing Harbour	——	240,000
Various unforeseen expenses	750,000	——
Total	13,500,000	7,900,000

Dredging and building of quays are included in these estimates. The cost per metre for a cellular steel quay amounts to approx. Fl. 4,000 in Curacao, whilst a block wall costs about Fl. 4,450 in Aruba.

The amounts mentioned above are a considerable expenditure for the treasury of the Netherlands Antilles, although it must be taken into account that in Curacao an important yield may be expected from the new sites. When giving assistance in past years, the Netherlands Government and Chambers of Commerce aimed at creating lasting values. Something had to be done on both islands, since the existing conditions were not tenable. No doubt more is now being done than is absolutely necessary, but it is realised that elsewhere in the Carribean Sea many harbours are being improved and extended, and therefore, to keep what we have and also to attract more traffic to our two well sheltered harbours, we have to make some sacrifice.

In this connection, I cannot do better than close with the words of one who knows intimately the shipping movement in this territory. In 1946, Mr. J. Hudig, then director of K.N.S.M., said, *inter alia*:—

> ". . . The development of shipping traffic in the Carribean Sea offers many possibilities to Curacao. Seeing the many islands, closely situated harbours and many inhabited territories, a well equipped harbour with additional services (such as K.N.S.M. O-boats), Curacao has a good future in sight. The rumours that others have the same plans are not without foundation, but Curacao, by its central and geographic position, provided the possibilities in the future are seen in time, will no doubt be the transit harbour. It is essential that cargo handling is done by modern methods in order to eliminate too exorbitant transhipment charges."

IMPROVEMENTS AT THE PORT OF STOCKHOLM.

In view of increasing trade, the Stockholm Port Authority has put in hand a programme of expansion and reconstruction. The Stadsgarden Quay in the inner harbour is being extended by 1,500-ft. and will be equipped with four warehouses and new cranes. Work is also about to commence on large-scale underground storage facilities and a 12-metre deep pier at the Loudden fuel oil wharf.

Discharge of cargo at the port of Stockholm during the first quarter of this year totalled 855,000 tons, exceeding the tonnage in the corresponding period of 1938 by 200,000. Export cargoes amounted to 101,000 tons, and this figure, although not reaching the 1938 total, shows a heavy increase compared with 1949.

Coast Erosion

An Enquiry into Causes and Remedies

By R. R. MINIKIN.

(Continued from page 51)

INFLUENCE OF TIDAL AND INDUCED CURRENTS.

An instructive example of the complexities of beach stability is that of Dover Harbour from the Prince of Wales Pier to the East Cliff, a distance of about 1,600 yards. Already we have examined some of the historical problems along this shore when it was open to the sea, but nowadays the problem is different. The half-mile stretch of town beach from Prince of Wales Pier to the bastion near Woolcombe Street is, on the whole, a stable heap of shingle which varies only slightly in profile from one year's end to another, but the easterly tip near the bastion " A " (Figs. 66 and 67) is most difficult to hold. The fluctuations of the profile at this point have in the past given cause for anxiety for the stability of the sea wall, and a few years ago a new wall of Frodingham steel sheet piles, 43 feet long, was driven as shown in Fig. 67. This photograph was taken a few months after the groyne No. 1 was erected. At the same time, a strong S.W. gale was raging outside the harbour with sea waves 12 to 15 feet amplitude, but the harbour waves on the beach were not more than 2 feet amplitude (as shown in Fig. 68). It will be seen that though the waves break in a gentle surge over the beach, further along the strand they break with a relative violence on the bastion face, and into the pocket, about 10 feet wide, between No. 1 groyne and the bastion. The photograph Fig. 69 shows this groyne twelve months later at low tide. It may be observed that the

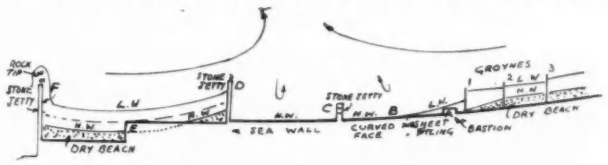


Fig. 66. Dover Harbour beach, eastern end.

pocket is full of shingle spilled over the top edge of the groyne from the adjacent crest, but that the beach in front is very low—actually, it is 2 to 3 feet lower than it was when the sheet pile wall was completed and No. 1 groyne erected. The old groyne which this new one replaces was originally only a few inches away and maybe for this reason alone the new one was sited in its present line. Had it been erected at the easterly corner of the bastion " A," it is more than probable that it would have been more effective in holding the beach. At No. 3 groyne (Fig. 70), the shingle reaches almost to the top of the sea wall; at No. 2 groyne it is 5 feet below; at No. 1 groyne it is 6 feet below; and at the bastion it is 9 feet below the promenade level.

The shingle beach virtually ends at the bastion and from the end of the sheeting wall " B " to stone jetty " D " there is a sea wall with a curved face, which is wetted at high and low water. There is an intermediate stone groyne at " C " (Fig. 71). To the east of the stone jetty " D " there is another long shingle beach (Figs. 72 and 73) fronting a stepped back sea wall " E ", terminating at the stone jetty " F ". These harbour beaches have a particular point of interest because they are subjected to a more or less regular pattern of tidal current and wave action. They are not subjected as open beaches are to varying obliquities of attack by storm waves. The waves entering the harbour by the western entrance have a greater influence on the west beach than has the weaker invasion through the eastern entrance. The predominant tendency of drift along this beach is S.W. to N.E. and is probably due to the internal circulating tidal current reinforced by the predominating wind direction. However, this main pattern of drift is modified in the region between the bastion " A " and the jetty " D ", where there is a surface neutral zone induced by the

Fig. 67. Projecting sheet pile bastion in sea wall.

Fig. 68. Dover Harbour sea wall showing portion where there is no dry beach.

Fig. 69. The bastion and beach at low tide.

circulating tidal current and the influx or efflux from the eastern entrance. At the same time, there is a weak drift east to west along the beach " F " to " D ". Arising from this it is probable that there is a bed current with a southerly set in the neutral area " A " to " D ", which causes a drawdown of the mobile material and militates against the beach-building in this area.

Thus it is further probable that the amount of shingle within the harbour increases slowly but steadily and that there is a more

Coast Erosion—continued

Fig. 70. New groyne (No. 3) on town beach west of bastion.

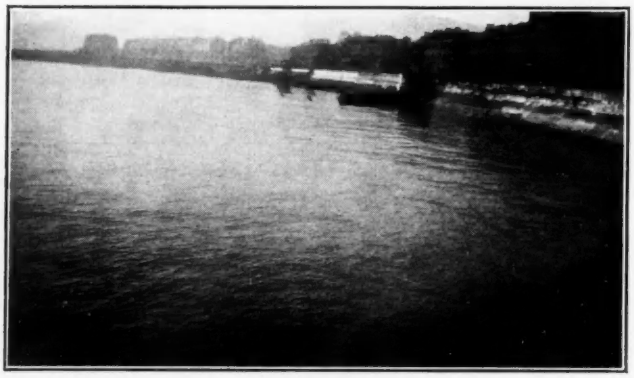


Fig. 71. Sea wall B to D with steeply ramped toe.

or less closed cycle of change of position along the beaches, the vulnerable part being that where the influences of the two entrances arrive at the beach together of equal strength, and reinforce the change in direction of the superficial tidal current, promoting also an offshore under-current. The latter is further assisted by the clapotis action of the waves at the impermeable face of the sea wall.

Comparing the two photographs (Figs. 72 and 73) of the beach "FD", which are taken from "D" and "F" respectively, it will be seen that the shingle in the root of the jetty "D" on the east is at the promenade level and maintains this height along the sea wall for some distance, then drops gradually to about 10 feet below promenade level at the projecting corner of the wall at "E", then rises to within 2½ feet of the promenade level at the elbow of the set back at "E", maintaining this height along the roadway to the root of the jetty "F". The illustrations also show that the low water line and the mean tide high water crest line are more or less parallel, which indicates that the lower beach slope is at a uniform slope throughout. The high water springs crest line is discernible in both photographs. This line is broken by the projecting triangle of the stepped promenade wall, but if the lines shown were joined up as shown dotted in Fig. 66, it will be seen that this also is approximately parallel to the above mentioned lines. This is a sure indication of a close uniformity of conditions between "F" and "D". It will also be noticed that the groynes above the beach are in bad repair and only the posts exist, whatever may be buried by the shingle.

It is evident from the uniformity of profile that this beach is mature, in spite of the high water contacting the corner of the wall at "E". Hence, should it be desired to increase the area of dry beach at high water, the greatest care would have to be exercised in the size and placing of the groynes. They should be low, certainly not greater than 12 inches, and must follow closely the existing profile with the sea end, extending 20-ft. or so seaward of the low water line. The sole reason for this is to facilitate the collection of the scattered migratory particles in heaps, since they then travel shoreward much more easily than they do individually across the sand. As they mount the slope there will be some point or points at which the heaps will increase in height and spill over to the lee, forming other heaps of forward progress, and thus level out over the groyne bay. Near all maximums conditions become fragile; and since a mature beach is of this character, groynes of a height that would prevent spill to the lee would bring erosive factors into play, and a saw-toothed contoured beach would result.

On many parts of the South Coast where costly beach protection works have been constructed, there is a sometimes a wide fluctuation of the amount of material forming the beaches. Over a few seasons the beaches appear to be not only mature but static, in the sense of permanency, then a sudden storm depletes them severely. Some are rebuilt in the course of a few days, while others take a considerable time, and some worsen with regularity and persistence. Again, the same storm may throw up enormous quantities of material, burying groynes and overflowing the sea walls. These occurrences foster the impression that there is a cyclic natural change and some engineers even venture to suggest a time period for the event. But it is not quite so simple as that. Very few natural unobstructed beaches suffer these irregularities; parts of the north-east coast, Bamborough, Alnmouth, Tynemouth and the Shields Bents Sands appear to enjoy an uneventful existence. When rapid changes do occur, there is cause for close investigation of the littoral below low water and neighbouring beaches to trace, if possible, the whereabouts of the depleted material. If no clue can be found, then there was an erosive force developed under the conditions of the elements at the time of depletion. Should the material be traced, however, to an accumulation on the lower beach, or an accretion on a neighbouring strand, then the probability is the effect was influenced by local conditions on the beach under the incidence of the elemental forces. If the beach had a saw-toothed contour prior to the

Fig. 72. Shingle beach D to F. Note fall of the beach at the wall to the corner E.

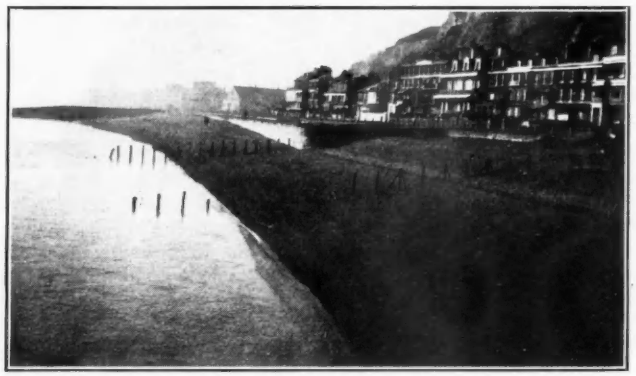


Fig. 73. The beach D to F from the point F. High water line is plainly visible.

Coast Erosion—continued

denudation, then the groynes were too high, or were wrongly sloped, or set at a wrong angle.

These fluctuating phenomena occur mainly on steeply sloping beaches, or where the still water level has been considerably heightened by an onshore gale. Even in places with slight exposure, for example, the groyne Fig. 74 is of the type to provoke fluctuations, as the beach is much too steep to favourably withstand heavy surge. The beach crest ridge is too narrow and a draw down is sure to take place if the waters top the crest. Further along this beach there is another new groyne (Fig. 75) better adapted for holding the beach, which is considerably lower than the one it replaces, of which the uprights still remain. Even so, this new groyne is too high, the top strake could be dispensed with. The crest is mature and will not advance further seaward until the beach at the lee, at the extremity of the groyne, is also increased in height; in other words, the sea bed at the outer tip must also have an increase of height on both sides of the groyne before a stable beach crest can advance seaward. Close to the groyne of Fig. 75, the observer flattened the crest on the retreat of the surge to note the reaction. The surge from the succeeding waves rebuilt the crest form by projecting the particles from the flattened portion and not from the apparently more mobile ones lower down the slope.

On the highly erodible coastline of blue clay on which the well-known resort of Herne Bay stands, the system of defence is worthy of attention. This is an area to which we have already referred as typical of clay strata. The sea protection schemes have been costly for little substantial returns. The foreshore is flat and the low water line continues to advance landwards. It will be seen from Fig. 76 that the beach at the eastern extremity has close spaced timber groynes with the remnants of a damaged timber sea wall at the foot of clay banks, which have been severely eroded of late years. The foreshore in front of the groynes is almost devoid of shingle, and in the groyne bays there is a very thin sprinkling of shingle. Obviously the supply is poor.

Fig. 74. Steeply sloping groyne and beach.

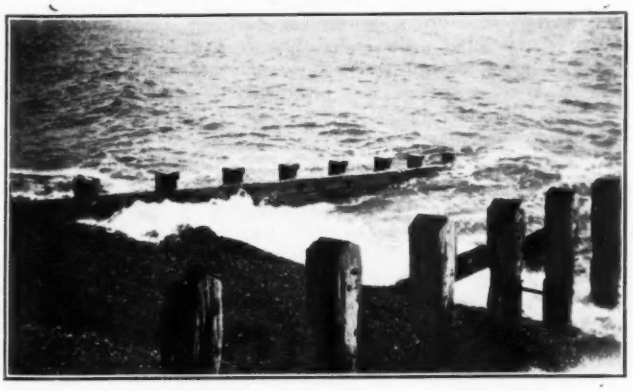


Fig. 75. New lower and less steep groyne. Crest building of waves in fine weather.

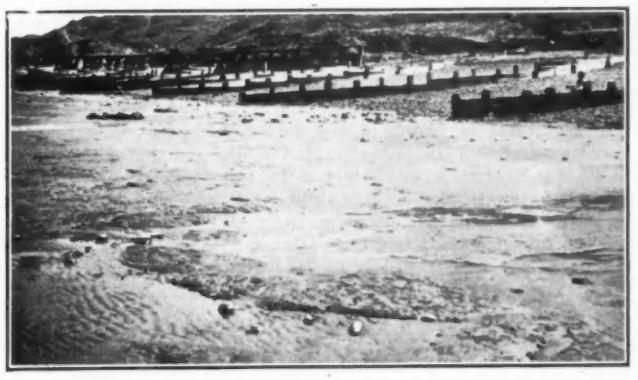


Fig. 76. East beach at Herne Bay. Clay foreground and banks.

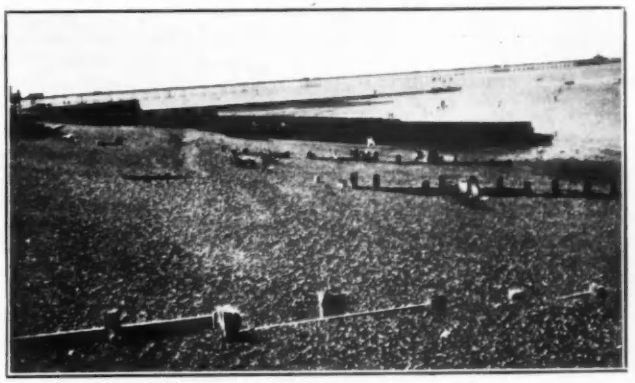


Fig. 77. Herne Bay. Stone jetty and piers.

The general tidal current on the flood sweeps almost parallel to the coastline, east to west, and favourably disposed to carry the shingle along from the chalk cliffs and rocks to the east, but the ebb tide current from the estuary is mainly deflected in a north-east direction, that is, obliquely away from the coastline towards the Essex coast. This is not favourable to beach building at Herne Bay. Another unfavourable feature is the wide expense of flat clay foreshore in the dry at low tide. The front faces north and is therefore exposed to the severe estuarial conditions peculiar to the Thames estuary during northerly gales, when waves (measured direct) in mid estuary often reach 20 feet in height. The result is that with abnormal tides in winter, Herne Bay is assailed by heavy choppy seas, which rob the beach of its sparse supply of shingle. When seas are favourable for recuperation, the thinly spread migratory particles over the flat clay of the foreshore must necessarily make wide detours before arriving on the upper beach. In fact, the scarcity of material on the beaches east of the Sea Pier has caused the local authorities to tip large quantities of imported shingle on the depleted beach to make up the deficiencies of natural supply and thus provide the amenities of a pleasure resort.

In circumstances such as these, it will be appreciated that the groynes of Fig. 76 project too high at the sea end, although they measure 18-in. to 24-in. only. They are about 50 feet apart and, since it is almost hopeless that the shingle at the extremities could ever reach this height, then there is no useful purpose served in these obstacles to a favourable run of the alongshore current. Fewer, longer and single strake shallow groynes would probably give better results and trap the particles on the bed before they by-passed the denuded beach. Further along the shore to the west, near the Yacht Club, there is a stone jetty which lies obliquely (70°) to the sea wall towards the east. This traps an appreciable amount of shingle near the root only. Still further west there is another stone jetty (Fig. 77), slightly longer than the timber groynes, which accretes fairly to the east, and where the very low timber groynes show the most efficient service; note

Coast Erosion—continued

the single strake tips and the even blanket of shingle, in spite of being thin. To the west of this jetty (Fig. 78) the groynes are not successful, but the accretion of shingle near the toe of the sea wall shows that there have been lively accretion conditions here at the expense of the part of the beach further west; note the bareness of shingle and exposed clay bed in foreground, also the added steepness of beach in the lee of the jetty; note also the lowness of the promenade level and the effect of the offset of wall. Still further west there is another stone (high) jetty and a ramped stone jetty giving on to a timber piled gangway to a landing stage (Fig. 79). Between the latter and the promenade bandstand there are four low groynes which are obviously doing no work at all, the shingle is a mere sprinkling at the foot of the ramped sea wall apron. There is hardly any shingle (in this section up to the Sea Pier) on the lower beach, about which are spread some foreign cobbles.

Now immediately to the west of the Sea Pier there is as efficient and stable an accumulation of shingle of large flints (Fig. 80) as could be found. The question that arises is why this beach should be so mature and the other adjacent sections to the east so poor. The configuration and water depths are little different and it does not seem possible that the long Sea Pier could have this influence, though such structures do favour the formation of eddy currents in their vicinity. It is more probable that the sets of the tidal currents and the comparatively closely spaced stone jetties assisting cause the shingle to by-pass the east sections in favour of the less active waters washing the west beach. The ebb tide from the Swale swinging out into mid-channel will in all probability set up bed eddies in this area and halt the transport of the shingle to the west. The other factors are the shallowness of the foreshore and the prevailing direction of the offing waves before they swing to the shore.

The problem of the Herne Bay beach is difficult and it appears to the author that better results might ensue if low, narrow, humped back groynes were extended to low water line at wide spacing in place of, or in addition to, those already existing.

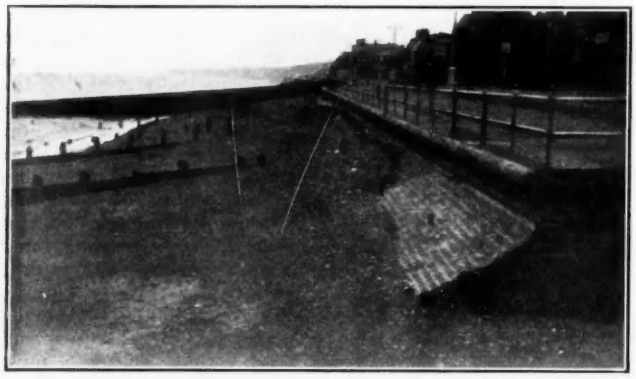


Fig. 78. Herne Bay. Low curved sea wall and stone jetty.

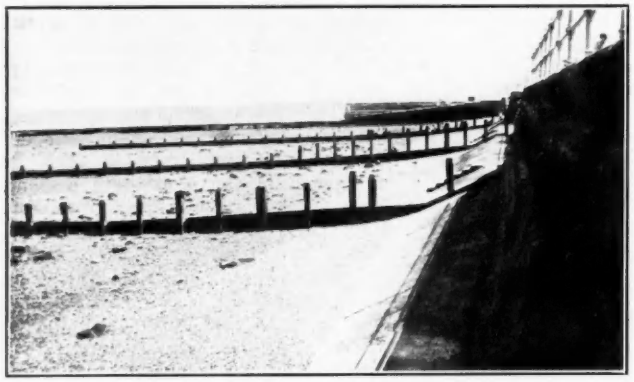


Fig. 79. Herne Bay. Timber and stone groynes and aproned wall.

Fig. 80. Herne Bay west beach.

Fig. 81. Hastings. Concrete groynes on shingle beach.

It is not without interest to compare the effect of well designed and sited concrete groynes at Hastings (Fig. 81), where the littoral supply of shingle is good. The photograph shows four; two in the foreground efficiently buried in shingle to the top, which falls at the natural inclination of the beach profile, the tips being equally buried. In the background there are two others at a flatter slope and too high at the extremities, thus provoking the inconvenience and danger of an eroded lee and a saw-toothed water line.

(To be continued)

Aluminium Dumb Barge for Export

The prototype of a 100-150-ton aluminium alloy dumb barge, which it is claimed by the Fairmile Construction Company, Ltd., Cobham, is the first to be built and launched in the United Kingdom, was shown in the River Thames to barge owners, export organisations, and other interested parties early last month. While of the familiar swim-ended Thames type, the barge is not specially designed to fulfil the requirements of users of the river, but has been built on jigs and fixtures for production for export, and to be delivered abroad either complete or in bundled sub-assemblies for erection on site.

One of the most important advantages of aluminium alloy over steel is its resistance to corrosion in fresh or salt water without any special protection, and no paint is applied unless specially required. The owner of a fleet of light alloy barges, therefore, will effect a substantial saving through not having to scrape and paint the hulls at regular intervals. The 100-150-ton barge costs £4,050, approximately £1,400 more than a steel barge of corresponding size. The draught is 6-in. when light and 4-ft. 7-in. when fully loaded. The hold capacity totals 5,210 cu. ft., the length overall being 80-ft. 3-in. and the breadth overall 20-ft.

Great interest in the barge has already been shown abroad, and enquiries have been received from America, Africa, Burma, Sudan, Portugal, India, Greece and the West Indies.

Some Modern Cargo Handling Appliances

Review of Mechanical Equipment used in British Ports

By E. S. TOOTH.

(Continued from page 63)

(3) FORK LIFT TRUCKS

As mentioned in Article 2 of this series, there is no doubt of the unqualified success which has attended the introduction of mobile cranes into the work of cargo handling in British ports. The same, however, cannot yet be said of the fork lift truck. This is an intriguing machine, the great potentialities of which have inspired experiment after experiment in the endeavour to ascertain how best it can be employed in handling both inwards and outwards cargo.

The fork lift truck is a mobile stacker. Its two horizontal protruding 'forks' are placed underneath the load by a forward movement of the machine. The machine then raises the forks sufficiently to lift the load off the ground and tilts its mast backwards a few degrees in order that the truck may carry the load with safety. The load can ultimately be placed on the shed floor or upon other packages up to the maximum height to which the forks can be raised—in a standard machine 9-ft. to 12-ft.

In order that the forks may easily engage the load and free themselves from it, the goods to be lifted are usually piled on a pallet. This is a contrivance for transportation and consists either of a platform resting on legs or runners or of two 'faces' connected by stringers. The palletised goods form a transportation unit which the machine handles by inserting its forks under the platform or between the pallet faces. There are individual instances of course where a package—a battened case, for instance — can be handled by the fork lift truck without first being placed on a pallet. This is the exception rather than the rule, however, and most packages are not only incapable of being handled singly by a fork lift truck but even if they were, individual packages usually are too small to make an economic load. Under present conditions, therefore, although British manufacturers of fork lift trucks have done their utmost to make the machines as versatile as possible—by such refinements as an attachment which converts the truck into a light mobile crane, special forks for handling barrels of beer and oil and hogsheads of tobacco, a clamp (instead of forks) which will grip the sides of 'square' packages and a form of attachment which enables rolls of paper to be stacked—despite this, it is not possible to give serious consideration to the general introduction of the fork lift truck into port work except in connection with handling goods first piled on pallets.

Palletisation is a simple and economic operation when large quantities of uniform packages are being handled. The fork lift truck is therefore the ideal tool for a factory. Its satisfactory introduction into port work, however, presents a complex problem. Although there is a widespread belief that this machine is the complete solution to the problem of mechanising quay and shed work, experience has not yet confirmed that belief. Taking exports as an example, it is often explained to the Port Official that the fork lift truck will unload palletised units from road or rail conveyance, convey them to the shed and pile them. Later, when the ship is ready, it will pick them off the pile and convey them to the ship's side for lifting aboard. That is the theory of its use. In practice, however, except in isolated instances, goods are not being tendered as palletised units and there is an enormous amount of ground to be covered before they will be. Because the potentialities of the machine are so great, the key to its successful use, palletisation, has for some time been exercising the keenest brains in the port industry and much research has been done, not only in this country but abroad—particularly in the U.S.A. and Sweden. As has been stated, only a small proportion of unpalletised goods can be handled by fork lift truck, and the feasibility of bringing it into full use in Great Britain appears to depend upon what type and size of expendable pallets are necessary, whether they can be produced on an economic basis, and whether there will be sufficient incentive to produce them, i.e. sufficient incentive to start the chain of events which will ultimately create the need for fleets of fork lift trucks in British ports.

The following are some of the questions yet to be answered and emphasise the volume of exploratory work still to be undertaken:—

(1) Can the Pallet Manufacturers evolve an "expendable" pallet, cheap enough not to increase the price of our exports and strong enough to allow units to be stowed in ships' holds in tiers,

(2) If not, can the use of "returnable" pallets be made an economic proposition?

(3) If the answer to either of these questions is an affirmative one, can it be made worth while for Manufacturers or Shippers of goods to palletise them (by offering them cheaper handling and freight rates, for instance)?

(4) Is it practicable to load a ship mainly with palletised units?

(5) If so, will the saving of ship loading time be sufficient to permit Shipowners to offer cheaper freight rates and also to compensate for the cargo space lost by the use of pallets?

(6) Can sufficient standardisation in size and type of pallet be achieved at international level, for (a) the same palletised units to be handled by the transport and machines of both the country of origin and the country of destination without loss of time and loss of undue space in road or rail vehicles, and (b) for the pallet to carry an economic load for all the handling operations to which it has to be subjected?

British Pallet Manufacturers have not been backward in designing pallets to meet the needs of our extremely miscellaneous export traffic. Many types of single and double-faced two-way and four-way pallets of both wood and metal construction are already available. Apart from the design, size is an important factor and there are 16 to 20 different sizes of square and oblong pallets in general use. These vary from 36-in. x 36-in. to 72-in. x 54-in.—but some of these 'standard' dimensions might easily be altered in the future by a standardising committee.

One type of expendable pallet in use is the single-faced 'pedestal' four-way article made of reinforced corrugated fibre-board. A development of the pallet is a stackable box with detachable sides for returning empty. Unfortunately, in an article of this description,. it is not possible to do much more than touch upon palletisation and it is with some regret that we leave so much unsaid about this fascinating subject, on which a small book could be written.

However, it should be obvious why, so far, palletisation is only a sporadic development. It only remains to add that, even if there were no manufacturing and operating difficulties, it is by no means certain how much of the traffic which passes through Britain's ports is even capable of palletisation. It may be a half; it may be three-quarters.

In the meantime, however, experiments have been and are being made at a number of ports with the end in view of bringing the fork lift truck into more general use. These experiments have often involved the purchase of stocks of pallets. At one port, packages of green fruit are piled on pallets in the ship's hold, and the loaded pallets, which are the property of the Discharging Contractors, are lifted ashore by crane or ship's derrick. On the quay, the loaded pallets are picked up by a fork lift truck which conveys them to a loading bank where they are deposited at the tail board of the receivers' van. At other places, certain

Some Modern Cargo Handling Appliances—continued

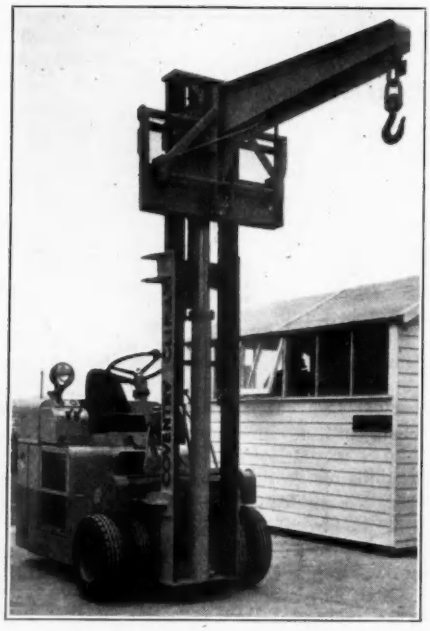


Fig. 1. Coventry Climax Fork Lift Truck fitted with rigid crane attachment for handling heavy or awkward loads.

exports are piled at time of receipt from road or rail conveyance on to pallets belonging to the Port Authorities or to other Employers of Labour. The fork lift truck then picks up the loaded pallets, conveys them to the shed and piles them. Later it will unpile them and convey them to the ship's side where their load will be hoisted into the ship's hold. In both the instances given, the fork lift truck has reduced man-handling, increased the speed of the operation and, in some cases, saved space by high piling. These are typical savings but there is still one important difficulty to be overcome before the machine can be used satisfactorily even in this limited way. Compared with the potential saving in man-power, savings in time and space are small. The enterprising employer, wishing to bring into use fork lift trucks and pallets can only do so if the resulting economic benefits are shared so that he can ultimately recover the somewhat heavy capital cost of the equipment he has provided. The satisfactory manning of gangs using fork lift trucks and the equitable sharing of the benefits derived from their use are questions to which, sooner or later, answers must be found. Like a crane or an electric truck or a conveyor, one fork lift truck can do the work of a number of men. The implications of this fact are real to employer and employee alike, and have got to be met and dealt with before a more general introduction into port work of this machine will take place, even when the problem of palletisation has been solved. The Working Party, which recently reported on Increased Mechanisation in the United Kingdom Ports recognised this matter as of primary importance, and their first Recommendation dealt with it.

The fork lift truck most generally used has a lifting capacity of 2 or 2¼ tons. Fig. 1 illustrates model FTF. 512 made by Coventry Climax Engines, Ltd. This robust machine has three point suspension, twin pneumatic tyres, hydraulic steering, and a turning radius of 83-in. Its width is 50-in. and its length, less fingers, 95½-in. Diesel driven, its capacity at 20-in. from fork heel is 5,000 lbs., which load can be lifted to a height of 12 feet in 18 seconds. The height of the mast lowered is 104-in.; when extended 173-in. Angles of tilt are: forward 3°; backwards 10°. The truck can travel at 7.5 miles per hour forward and 10.8 miles per hour in reverse. The model in the illustration is fitted with rigid crane attachment for lifting heavy or awkward loads not easily handled on the forks or by the pallet system.

As with the mobile crane, to get the best out of the machine it must be driven by an expert. It will be noticed that the lifting capacity is controlled by yet another new factor in cargo handling machines. The centre of gravity of the package lifted must not be more than a certain number of inches from the heel of the forks. With the model illustrated the distance for the maximum load is 20-in. This brings into consideration the distribution of the weight of the contents of packages, particularly of cases and crates, and in some instances the driver must test the ability of his machine to handle a package before he can be sure it is safe to make the lift. Travelling with his load is another operation to which the driver must pay especial care. After the load is lifted (and it is only necessary to raise it a few inches from the ground) the fork masts are tilted backwards to increase the safety margin when the truck is moving. Besides the total weight of the package, therefore, its centre of gravity and the gradient of the surface upon which work is proceeding must be taken into consideration. When bulky packages of a lighter weight than the maximum capacity of the machine are required to be handled, fork extensions may be fitted to make this possible.

Fork lift trucks used for work on quay or in transit shed, are usually powered by diesel or petrol engines. Because of potential fire risks, or of the effects fumes would have in an enclosed space, such machines are not always suitable for warehouse work and a battery-operated machine is sometimes employed instead. It is in this sphere, especially where a warehouse is allocated to a particular commodity, that the fork lift truck can sometimes be used without the necessity to palletise.

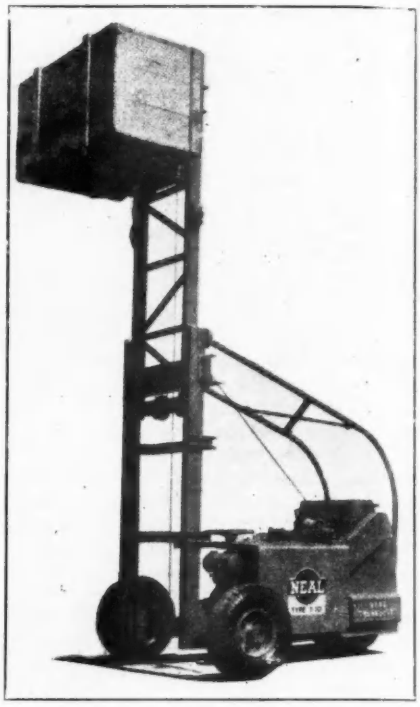


Fig. 2. Neal Fork Lift Stacker.

Fig. 3. Ransomes & Rapier Heavy Duty Fork Lift Truck.

Some Modern Cargo Handling Appliances—continued

The handling of hogsheads of tobacco is a case in point. At one London dock these goods are landed into the warehouse by means of electric crane and, after weighing, are conveyed to the stowage ground by electric platform truck. Here they are rolled off the truck, some forming the ground tier of the stowage, others being lifted on top of them by fork lift truck. This is one of the satisfactory and economic operations which, because of the shape of the packages to be handled, can be performed without the use of pallets.

There are of course light and heavy duty fork lift trucks, most of which are built on standard principles. The light machines usually have a lifting capacity of 10 to 20 cwts. with the load centre up to 18-in. from the heel of the forks. They lift to a height of 6-ft. to 12-ft. Most are petrol driven but there are a few battery machines which give equally good service. There is a light machine built on an unconventional principle in which the lifting operation is performed by means of a hoist drum and a wire running through a train of sheaves, which elevates the fork frame. Lowering is by gravity. This machine, the Neal T. 10 Fork Lift Stacker (Fig. 2), will lift at a speed of 40-ft. per minute, a load of 10 cwt. to a height of 12-ft., with the load centre 18-in. from the heel of its 3-ft. forks. The height with forks lowered is 8-ft. 3-in.; with forks fully raised 14-ft. 3-in. The machine is 11-ft. 1-in. long and 5-ft. 3-in. wide. It has two front wheels and one rear (steering) wheel by means of which it can be made to rotate about the centre point of its front axle. The minimum turning radius is 5-ft. 10-in. It is fitted with heavy duty pneumatic tyres and has a travelling speed of 2½ miles per hour. The power unit is an air-cooled 6 h.p. J.A.P. industrial petrol engine which consumes only about 2 gallons of petrol per 8 hours work.

Certain berths frequently handle cargo which includes a fair percentage of heavy packages so constructed that they can be lifted without employing pallets. The heavy duty fork lift truck is an excellent machine for handling these, which it does without risk of injury to the workmen or of damage to the packages.

One such machine is the Ransomes and Rapier model 18/24 (Fig. 3), which will lift a load of 18,000 lbs. (i.e. 8 1/3 tons) at 2 feet from the heel of the forks to a height of 17-ft. 6-in. With either a petrol or a diesel engine, the travel drive is direct and the hoist and tilting of the mast are by hydraulic power from a pump driven by the engine. The truck has three point support on six pneumatic tyres (four front and two rear) and, for travel, three speed forward and three speed reverse gears. Control of the hydraulic lift and tilt is at the touch of a lever; the rest is like driving a van.

This machine can be fitted with a short or a long mast. With the former, the lift is 12-ft. 6-in.; with the latter, 17-ft. 6-in. as stated above. In either case, the lifting speed is 55-ft. per minute and the lowering speed 60-ft. per minute. The mast tilt is 4° forward and 12° backwards. The maximum travel speed is 12 miles per hour either forward or reverse. The 4-ft. (standard) forks are adjustable for the width of the load and special forks or finger extensions can be fitted so that lighter but bulkier packages may be handled with safety. The length of the truck (without forks) is 14-ft. 9-in., the width 7-ft. 8-in. and the radius of turning circle 14-ft. 6-in. The working weight of the machine is slightly under 12 tons.

Another heavily constructed special duty machine is the "Matbro Pneustac," a fork lift truck which will lift a load of 2 tons at 18-in. from heel of forks to a height of 9-ft.

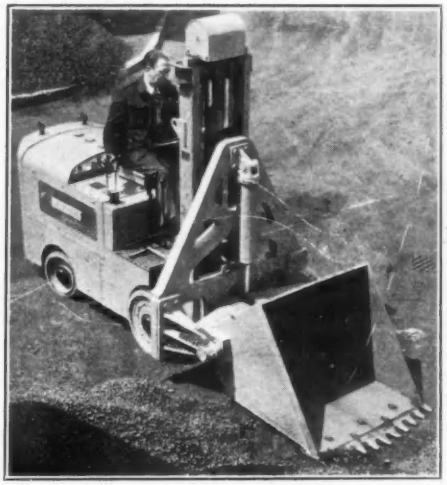


Fig. 4. "Stacashovel" mechanical shovel.

in 20 seconds. Its main difference from the conventional machines, is that it can transport loads over very rough ground and for this reason it is described by the makers, Mathew Bros., of Wallington, Surrey, as a "cross country" fork lift truck. In a recent demonstration it carried a 30-cwt. load satisfactorily over artificial obstacles 6-in. high. One obstacle was a railway sleeper. Its length, less forks, is 10-ft.; wheel base, 83-in.; ground clearance, 6-in.; speed, up to 15 miles per hour; and unladen weight 6,900 lbs. to 7,500 lbs.; according to model. The heaviest model, which is diesel driven, is fitted with heavy duty twin pneumatic tyres. All models have three speeds forward, and reverse; the angle of tilt of the masts is 10° back and 3° forward.

This "cross country" machine has a larger chassis and therefore requires more manœuvring space than the fork lift truck used for shed work. However, since its main use is for handling goods stowed in the open and, particularly for conveying them over rough ground (for which the conventional type of machine is usually unsuitable), this disadvantage is more than offset by the special duties of which it is capable.

It has already been stated that the fork lift truck has been introduced into port work for a number of miscellaneous operations. It remains only to reaffirm that it is the most potentially revolutionary machine at present in use in British ports and to emphasise that its employment in the port industry is largely in the experimental stage. At present it is in the main performing only part of the complete operation for which it is hoped ultimately to find means of employing it and its **full** introduction depends to a large extent upon two factors — the evolution of the pre-palletisation of export cargo and the co-operation of the port workers. The former, particularly, will be a slow process but as it gets under way, the latter must become a reality. In the meantime the position is developing where the pallet is being used in British ports as a stillage board on which goods are piled only whilst they are on port premises. Much time and space are saved by employing this method, which also decreases the number of times individual packages must be manhandled.

There is also a potential saving of man power and unless the proportion of palletised units passing through our ports from point of production to point of consumption becomes substantial, there is no doubt that Dock Authorities will bring more and more fork lift trucks into use for handling and piling loaded pallets not palletised units but loads on pallets which, in effect, are being used as stillage boards.

Before terminating this section it will be worth referring to a machine built on the same principle as the fork lift truck, the mechanical shovel, which is sometimes used in ships' holds for discharging cargoes of bulk ores. It was developed to meet the need for a manœuvrable machine capable of digging into, lifting and transporting loose materials of all descriptions. The 'Stacashovel' (Fig. 4), has a bucket capacity of 17½ cu ft. and employs a hydraulically-operated digging and lifting device by which the bulk commodity to be handled is picked up, lifted and tipped into the receptacle in which it is to be hoisted from the ship's hold.

As with the fork lift truck a 'standard' model is capable of a 9-ft. lift but shorter masts for working in restricted head room can be fitted. In port work, this machine too is in the experimental stage. Of course, discharge by grab is often speedier but when there is a stowage of bulk cargo away from the plumb of the hatch—as there sometimes is in a large hold having a comparatively small hatchway—a mechanical lifting shovel can be used to advantage.

The next article deals with a number of other machines which convey and pile goods but which, in many instances, have already become such an everyday feature of port work that some gangs look upon them as almost their own personal property.

(To be continued)

Modern Excavating Plant

Review of Recent Developments

(Specially Contributed)

INTRODUCTION

The last twenty years have seen a tremendous revolution in the design and construction of excavating plant, which has been reflected in dock engineering by the increasing tendency to employ the open type of excavation rather than the trench method; a good example of this is the Sturrock Graving Dock at Cape Town.

Less than a quarter of a century ago it was common to see cumbersome steam navvy shovels and draglines at work on dock and harbour construction, and although steam has the undoubted advantages of flexibility in power output and the capacity to exert high digging effort at stalling point, the extra labour charges and standby losses involved, combined with heavy weight and a relatively low working time factor, militate against its use except under special conditions.

Today, the whole outlook on mechanical excavation has been completely altered by two outstanding technical advances, namely: the advent of the commercially successful high-speed compression-ignition oil engine, and the evolution of various tracklaying devices which have facilitated work on soft and waterlogged ground. Many people, even engineers, may not be aware that the famous patents for an oil engine in the names of Herbert Akroyd Stuart and Charles Richard Binney of 1890, were granted some three years before those taken out by Dr. Diesel in 1893.

Moreover, British engineers can justly claim to have been pioneers in the development of a successful tracklaying tractor which was designed by David Roberts, Managing Director of Richard Hornsby and Sons, Ltd., Grantham, who won a prize of £1,000 offered by the British Government in 1905 for a military tractor that would run 40 miles carrying its own fuel. This historic machine was powered by a two-cylinder Hornsby oil engine, and the vehicle was promptly dubbed "caterpillar" by that ever-ready wit, Tommy Atkins; it is therefore from Aldershot and not from America that this apt description originates. It thus appears that David Roberts and his colleagues at Richard Hornsby's works were pioneers in the evolution of the tracklaying tractor, for they were the first to make a successful vehicle which could haul heavy loads over boggy ground, loose sand, or up an incline of 1 in 2 on slippery clay.

The modern high-speed oil engine provides the civil engineering contractor with a very efficient, compact and reliable power unit which has proved its worth under the most gruelling conditions imaginable. Although some of the smaller excavators are powered by petrol engines, there is an increasing trend towards installing oil engines, mainly owing to their low running cost, diesel oil being considerably cheaper than petrol, and complete safety from the serious fire risk involved in the use of a high volatile fuel.

In those cases where extreme mobility is not essential, large excavators are frequently driven by electric power from a mains supply, through trailing cable. This drive may take several forms—The main driving motor may be of the constantly running type, or a diesel-electric system may be installed with individual electric motors driving the hoist, crowd and slewing motions. Again, an A.C./D.C. current system may be used, having an alternative current motor in place of the oil engine used in the diesel-electric drive mentioned above.

WARD LEONARD CONTROL

In recent years, the Ward Leonard control has become increasingly popular for the drive of large excavators; in this system an induction motor drives separate generators which are connected in closed armature circuits with the crowd, hoist and slewing motors. This system is extremely convenient, for it provides maximum voltage at low current and maximum current at low voltage, thereby giving high torque at low speeds and low torque at high speeds. It is extremely efficient, and practical experience has proved that its maintenance cost is low, with excellent control at high operating speed or at maximum digging effort. Furthermore complete protection is assured against overload currents in the armatures.

The layout of the Ward Leonard control system in the Rapier 490 type excavator is shown in Fig. 1, and this is claimed to give the essential characteristics formerly obtained from steam machines, but with greater economy. In this excavator drive there is a direct current variable voltage with field control system in which separate motors for the hoist, crowd and slew motions are connected in closed armature circuits with separate generators. The latter are driven by an induction motor from the main supply and are mounted on a common baseplate forming a single unit at the rear of the machine. A separate motor generator set is used for exciting the field.

Generator characteristics ensure that maximum current taken by any motor is limited to such a value that no high momentary peaks occur on the power line. Also, maximum torque exerted by the motor is limited so that machinery and structure are protected against excessive overload without the use of relays and without depending upon the judgment of the driver.

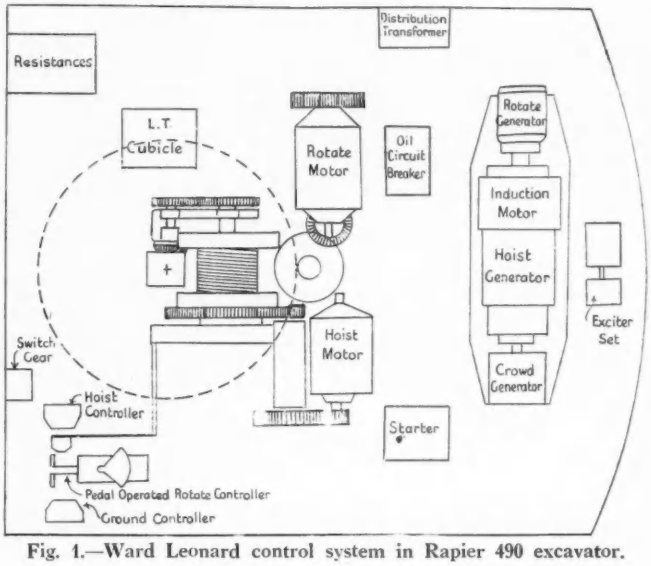


Fig. 1.—Ward Leonard control system in Rapier 490 excavator.

The feature of high speed at light load saves time, while the lower speeds at heavy loads save power and reduce wear and tear. This may be particularly useful in dock excavation, where the bucket will probably have to be nosed among heavy rocks with speed and certainty; maximum effort can be applied to the bucket without danger of stalling. Another important point is that there are no starting losses each time the motors are switched on, as the commutator circuits are permanently closed. Current consumption is very low because all lowering and braking operations are controlled through the regenerative braking system, which passes back current into the supply line; the smooth retardation thereby obtained results in lower wear and tear and there are no friction surfaces which require periodic adjustment or replacement. The generator acts as a cushion against shock loads, and the whole machine can be stalled without shock when digging load is excessive. Each motor is geared directly to its appropriate motion, with complete absence of flexible couplings and slipping clutches.

Careful attention has been devoted to simple driving arrangements in this machine, the drum type controllers handling only small shunt currents, and rapid operation of the controllers cannot damage machinery or electrical equipment. There is no complicated contactor gear, which is often liable to give trouble, especially under the rough conditions associated with public works contracts in general and with dock excavation in particular.

Modern Excavating Plant—continued

DIESEL-ELECTRIC DRIVE

This machine is also available in the diesel-electric form, so as to be able to use this method of independent drive in situations where electric power is not obtainable or where it is inconvenient or expensive to bring a power line to the site. Layout of machinery and equipment is the same as on the electric machine, except that the high-tension collector gear, induction motor and starter are replaced by the oil engine and its ancillary equipment. Drive between oil engine and generator is by Vee ropes, which transmit the power smoothly and efficiently to provide correct speed ratio, so that both engine and generator set run at their normal speeds.

Fig. 2.—Ruston-Bucyrus 3½ cubic yard quarry shovel.

In Fig. 2 we have an example of a heavy quarry type shovel by Messrs. Ruston-Bucyrus Ltd., with a bucket capacity of 3½ cubic yards and all-electric drive with Ward Leonard control; power being supplied through a trailing cable. The machine is shown loading ironstone into steel wagons, and the type of excavation is very similar to that which would be encountered in many instances of dock and harbour construction. The approximate weight of this machine is 124 tons and the output of the power unit 200 h.p.; notable features are the sturdy construction of the boom and dipper arms, the wide crawler tracks giving low pressure on the ground, and a turntable of ample dimensions.

One of the most remarkable technical developments in large excavators has been the evolution of the walking draglines. The author has had experience of the walking dragline excavator on opencast coal mining in this country, from which he is able to give output figures, but these are only approximate guides because so much will depend upon local conditions. In fact, it may be said of mechanical excavation generally that it is most difficult to establish any basis for comparative costs, and it would be definitely dangerous to lay down any hard and fast rules on the subject.

OUTPUT OF WALKING DRAGLINES

The first machine considered is a Monighan 6W type walker, built about 1934 and powered by a Fairbanks Morse four-cylinder oil engine developing 300 h.p.; with a jib length of 150-ft., this machine normally operates with a bucket of 6 cubic yards capacity. From output figures taken at random over a large opencast coal site, excavation varied from a maximum gross hourly output of 335 cubic yards to a minimum of 183 cubic yards, the average hourly output over a period of six months being 246 cubic yards, at a digging depth varying from 30 to 50 feet; the ground comprised approximately 60 per cent. of broken rock, 30 per cent. of hard dig, and 10 per cent. of soft overburden.

The second machine is a Ruston-Bucyrus 5W type walker, operating on the Ward Leonard system of control, current being supplied by trailing cable; the main driving motor is a B.T.H. 200 h.p. unit, the jib length being 135-ft. and the normal bucket capacity 4 cubic yards. This machine was built in 1944. Its output was greater than the Monighan, owing to the fact that the overburden on top of the coal seam was shallower and there was less rock in this part of the site; an electric machine is also quicker in its movements than the corresponding oil engined counterpart.

In this case the average output for a period of three months was 266 cubic yards an hour, at a digging depth of from 25 to 35 feet, the respective percentages of rock, hard dig and soft overburden being 60, 30 and 10. Output for both machines was calculated on hours actually worked only on excavation without making any allowance for standing and "walking" time. The former averaged about 3 hours in 24, the latter amounting to about one hour a day taken up in walking to a new position. Both machines were operated for 24 hours a day, the average width of cut being 60-ft. and the maximum depth excavated about 65-ft.

The dragline has much to recommend it, because it does not suffer from the same limitations in depth of digging, range or height of casting of the face shovel. On the other hand, it cannot exert the same digging effort as the shovel and when working in hard or rocky material, it cannot work efficiently unless the ground is first loosened by blasting. The dragline is therefore extremely valuable for loose and broken ground, but for excavating rock and boulders the face shovel must be used to meet successfully the gruelling conditions.

In passing, it is interesting to note that among the many orders now in hand at the Rugby works of the British Thomson Houston Co., Ltd., is one for the electrical equipment of the largest walking dragline so far built in this country, and in some respects the largest of its kind in the world. The dragline itself is being built by Messrs. Ransomes and Rapier, Ltd., Ipswich, to the order of Messrs. Stewarts and Lloyds, Ltd., for use at the ironstone mines at Corby; when completed, it will weigh about 1,500 tons.

It will have a bucket capacity of 20 cubic yards and a boom 282-ft. long, the power being all-electric with amplidyne-controlled Ward Leonard equipment providing a nominal power of 900 h.p. for each of the hoist, drag and walk motions, and 450 h.p. for the swing motion. Another feature is that two synchronous motors, each rated 1,200 kVA driving the main motor-generator sets will be maintained by a single amplidyne at unity power factor under all conditions of load. This fine British achievement is briefly mentioned in order to show the trend of modern development and to prove that British engineers are fully capable of building the largest excavators.

UNIVERSAL EXCAVATOR

So far we have considered the larger type of excavator, but in dock and harbour construction there is ample scope for the employment of the universal excavator, in which the same jib is fitted with appropriate attachments as indicated by the sketches in Fig. 3; these illustrate the attachments of a Smith Seven excavator, which weighs 7¼ tons and has a bucket of 8 cubic feet capacity for ordinary duties. Larger buckets, up to a capacity of ½ cubic yard, may be safely employed for easy digging or for loading purposes.

The machine is mounted on a standard tracklaying undercarriage, each track being 12-in. wide, embodying the interlocking design to prevent trapping of dirt and stone. Power transmission is through duplex roller chain drive totally enclosed in an oil bath, enabling the engine to be located well to the rear of the machine, thereby eliminating deadweight and providing a good space between engine and machinery.

The crowding of the navvy bucket is taken care of by the luffing action of the jib, and the back acting trencher is an extremely useful tool for those many trenching jobs which are always cropping up in dock work. The skimmer scoop is useful for trimming slopes, and the bucket for this is the same as that for the trencher; another useful attachment is the bucket for narrow trenches, the use of which eliminates a good deal of wasted effort. The dragline bucket, steel lattice jib and steel channel jib are all standard designs and do not call for any special comment.

Output of the navvy shovel is about 360 cubic yards a day, excavating and loading into lorries; when working in red marl, it can excavate nearly 23 tons an hour, and can load granite chippings

Modern Excavating Plant—continued

into a lorry at the rate of 40 tons an hour. Using the special narrow trencher attachment, it can excavate a trench through difficult material 18-ins. wide and 3-ft. 6-in. deep at the rate of 200 lineal yards for an 8½ hour day; it can also excavate a trench 2-ft. wide and from 3 to 4 feet deep at 200 lineal yards for a 7½ hour day. A trench in heavy clay 12-ft. deep can be excavated by this machine at the rate of 16 cubic yards an hour. The capacity of the skimmer scoop averages 1,400 cubic yards in 48 hours, and its capacity when loading sand is at the rate of 400 cubic yards for an 8½ hour day; the dragline can excavate a mixture of sand and clay at the rate of 300 cubic yards for an eight hour day.

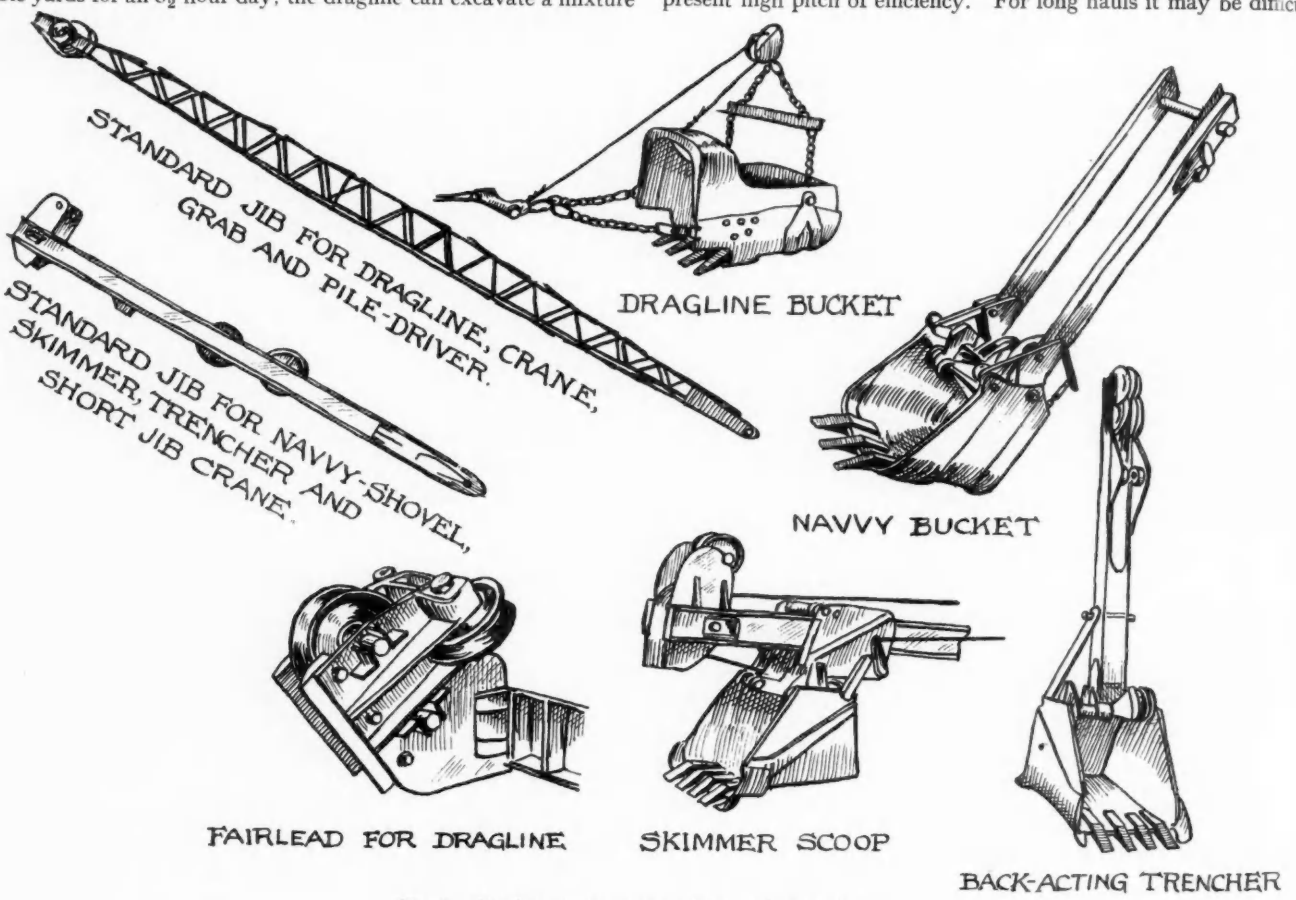

STANDARD JIB FOR DRAGLINE, CRANE, GRAB AND PILE-DRIVER.
DRAGLINE BUCKET
STANDARD JIB FOR NAVVY-SHOVEL, SKIMMER, TRENCHER AND SHORT JIB CRANE.
NAVVY BUCKET
FAIRLEAD FOR DRAGLINE
SKIMMER SCOOP
BACK-ACTING TRENCHER

Fig. 3.—Attachments for universal type of excavator.

This versatile machine has many outstanding advantages, being able to tackle practically any type of excavation work, the attachments being convertible at short notice. For short journeys this excavator can travel under its own power on the highway, for which a licence is necessary, but it can easily be mounted on a trailer for travelling at high speed over long distances.

TRACTOR/SCRAPER EQUIPMENT

In the last few years there has been a notable increase in the use of tractor/scraper equipments, which are now applicable to a wide range of excavation, but are generally most suitable for those sites where the area is large and the depth relatively small. Although until recently most of this machinery has been made in the United States, many British firms are now entering this specialised field with considerable success. The ideal aimed at by the designer and builder is to produce a machine which will both dig and transport material at minimum cost per unit volume over a long working life.

The use of soil scraping, bulldozing or similar equipment is largely determined by the length of haul involved in the job. For very short hauls the bulldozer and bull grader are excellent equipments, and the author has seen two bulldozers working together pushing back material into an excavation at the rate of 100 cubic yards an hour. For moderate hauls a good equipment is the tracklaying tractor pulling a soil scraper, and for long hauls the same scraping equipment but using a wheeled tractor. Incidentally, the large-size pneumatic tyre is one of the most important technical advances in this type of equipment, for without its aid it is unlikely that the large soil scraper would have reached its present high pitch of efficiency. For long hauls it may be difficult to decide between a soil scraper equipment and a single bucket excavator with dump trucks, narrow gauge track and diesel locomotives.

The economic limit to which the bulldozer can move material is between 250 and 300 feet, and experience has proved that the corresponding limit for a wheel tractor-scraper unit lies between 1,000 and 1,500 feet. These again are only approximate limits, because local conditions vary so much and each case must be considered on its merits. W. Savage has referred to the sphere of usefulness of the various types of units in a recent paper* pointing out that it is more difficult to compare the relative merits of the wheel tractor-scraper and the single bucket excavator with dump trucks, than to compare the former with the tracklaying-tractor drawn scraper, since comparisons have to be made over a very wide range of haul lengths. The latter does not normally deal with one-way haul lengths greater than about 1,500-ft. In the shovel-dump-truck combination, this range is extended to extend to about 10,000-ft., or a total round trip up to 4 miles.

*" Excavators, Tractors and Tractor Equipment " by W. Savage, M.I.Mech.E. Journal Inst.Mech.E., 1945, vol. 152, No. 2.

Modern Excavating Plant—continued

RAIL TRANSPORT

On all civil engineering contracts and particularly on dock and harbour developments, and on land reclamation, rail transport will continue to be used because it can be so readily and easily adapted to the particular work in hand. Generally speaking, it is the most economical form of transport where large quantities of material have to be moved reasonable distances. Cost of laying a railway will certainly be less than that of building a road, for in many cases there are no roads in existence. From his own experience on large scale excavation work, the author strongly advocates a careful survey of the proposed route of a railway for handling bulk excavation; it is worth planning this carefully, because, by avoiding heavy gradients, it will be possible greatly to increase the hauling efficiency of locomotives.

Maximum gradient should be limited to 1 in 100, gradients in favour of the load being limited to 1 in 50; any gradient steeper than the latter may mean that a brake wagon will have to be attached to the end of the train, thus adding considerably to the cost of excavation. Ratio between minimum radius of curvature and maximum wheelbase of the rolling stock, including the locomotives, should be not less than 20 to 1, and it is an advantage if the proportion is even more generous. Frictional resistance is greatly increased by sharp curves, and there is also greater risk of derailments, which can sometimes cost a great deal.

For reasonable loads the track weighs 20 lbs. per yard, resting on steel sleepers spaced at one yard intervals with clip and bolt fastenings; the gauge is generally 2-ft. and such track is suitable for a maximum axle load of about 2½ tons. Side tipping wagons are standard items of equipment, and are available in ½, ⅔, 1, 1⅓, or 2 cubic yards capacity; locomotives for such rolling stock may have a maximum weight of 5 tons and a power unit ranging from 20 to 30 brake horsepower, giving a normal speed of from 6 to 8 m.p.h. with a loaded train.

The track for heavy permanent way may have rails weighing from 35 to 90 lbs. per yard, mounted on steel or wooden sleepers, generally spaced at 30-in. centres; gauges may be from 3-ft. to 4-ft. 8½-in. and maximum axle loads will vary according to the weight of the rail used. Heavy side tipping wagons are employed on such track, with V-shaped bodies and having capacities of 3, 4, 5, 7½ or 11 cubic yards. Locomotives may vary in power from 40 to 200 h.p., powered by steam or oil engines; speeds can vary from 15 to 30 m.p.h.

DREDGING EQUIPMENT

Excavation of canals, dock basins and graving docks demands a very wide range of dredging equipment, which can be broadly classified under the headings of grab dredgers, bucket ladder dredgers, dipper dredgers and suction dredgers. The bucket dredger is the most universal apparatus, as it is applicable to a wide range of work. When dredging hard material it is found that the belt-driven type of dredger gives the best results, since the belt will tend to slip under heavy or unexpected shock, and it thus acts as an automatic safety device. Modern practice inclines towards the use of a vessel capable of carrying out two operations, dredging by buckets which discharge into hoppers alongside, or dredging the soil to a pump which discharges it ashore through a pipe-line for reclamation or similar purposes.

Sir Henry Japp has described the removal of underwater rock, a field in which Messrs. Lobnitz and Co., Ltd., of Renfrew have established a world-wide reputation. They built the first rock breaker, the *Derocheuse* in 1887, and they were still supplying spares for her in 1936; she did a great deal of work on the Suez Canal. In the original design of their rock breaker, the cutter was guided at about deck level and had to be long enough to reach the rock face. The modern design employs the Lobnitz patent underwater guide, which consists of a heavy steel tube lined with wood, in which a short and sturdy cutter is allowed to drop under its own weight. It thus works under complete control to depths ranging from water level to more than 60-ft. Since the guide is entirely under water and separate from the hull of the rock breaker, all shocks are cushioned; moreover, when the cutter is dropped through the guide the effect is similar to that of a syringe, debris being removed from the surface and allowing the cutter to deliver a blow which is not cushioned by a layer of sand or rock.

In a recent paper Sir George Burt referred to a very efficient rock-breaker which can be made out of an ordinary pile barge.* The pile frame is mounted on the stern of the barge, and the winch, instead of lifting the monkey for driving piles, operates a long chisel which can be fitted with a single renewable point. There may be several renewable points, but this will depend upon the nature of the rock being broken. A rock-breaker of this type was used with much success for breaking the masonry invert of a lock at the Surrey Commercial Docks, where the material to be broken was mostly brickwork.

BUCKET DREDGERS FOR ROCK REMOVAL

D. E. Paterson has referred to the use of bucket dredgers in conjunction with rock-breaking equipment at Cape Town, when excavating within the confines of the cofferdam for the Sturrock Graving Dock† About 100,000 cubic yards of material was removed by bucket dredger, including that portion of rock which had been uncovered and loosened by rock breakers. Cost of dredging was 3s. 4d. per cubic yard barge measurement, whereas rock breaking alone not including dredging cost 4s. 7d. per cubic yard. Underwater rock breaking is therefore a relatively expensive business.

In this case excavation was carried out by means of Ruston Bucyrus oil engined shovels attended by 3 ton end-tipping Ford petrol driven lorries, the number of lorries in attendance varying according to the length of run. Four of these shovels working for a nine hour shift removed between 1,100 and 1,500 cubic yards of solid rock in that period. The site was laid out with road access to all parts of the excavation from the surface.

Dredging by grab is a very convenient method, and in this field Messrs. Priestman Brothers, Ltd., of Hull, have achieved an unique position. A diesel-electric grab dredger was recently built by Messrs. Ferguson Brothers of Port Glasgow for the Mersey Docks and Harbour Board; she is fitted with Priestman grab cranes and this type of power transmission provides constant current. The three high-speed grab cranes each have a capacity of 3½ tons, the hopper of the dredger holds 1,350 tons and it is filled in 110 minutes.

The grab crane is a very useful tool for such varied work as excavation in heavily timbered trenches, loading material into bins, and for the sinking of open cylinders and monoliths, work which frequently has to be carried out in dock and quay construction. It is particularly valuable for underwater excavation either in the open sea or in a confined space, close to a quay wall, or for handling shattered rock below water.

The following average outputs for grabs are given by R. A. Japp‡ based on 5-ton steam cranes and grabs loading into 4½ cubic yard wagons:

Type of Work	Average output in Cub. yds. per hour
Open excavation in Thames ballast for dock	30.0
Wide dock wall timbered trenches in Thames ballast ...	10.8
Loam and Thames ballast	20.2
Grabbing from clay stock heap	23.6
Steel piled and timbered cofferdam, gravel and stiff mud	3.3
In narrow timbered trench—Thames ballast and blue clay (shallow)	3.6
Ditto, ditto (deep)	2.7

BASIC OUTPUT OF EXCAVATORS

Japp stresses the point to which the author has already referred, namely, that the output from single bucket excavators varies widely depending upon working conditions. However, no engineer

*" Machinery and Plant in Connection with Civil Engineering Construction " by Sir George Burt, M.I.C.E., Journal Inst.Mech.E., 1945, vol. 152, No. 2.

†" The Sturrock Graving Dock, Cape Town " by D. E. Paterson, O.B.E., M.I.C.E., Journal Inst.C.E., October, 1947.

‡" The Choice and Application of Modern Excavating Machinery " by R. A. Japp, A.M.Inst.C.E.I., Trans. Inst.C.E. Ireland, vol. 72, 1946.

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will be far out if he accepts the figures of the Ministry of Works in this country for the basic output, over which bonus is paid to drivers. These figures assume excavation in moderately stiff clay measured in the solid, and adjustments must therefore be made for other materials; this leads us back to the figures given earlier by the author for the output of walking draglines, which were based on estimated percentages of various types of ground and these percentages could only be guess work at the best.

The Ministry of Works state that for loose soil or sand the basic rate may be doubled, while for soft rock the basic rate may be taken at one-third of the values given in the Ministry's very useful and practical tables. Japp points out that on this basis skilled drivers may average 100 per cent. above these figures with the bonus incentive, but that " . . . . such figures should be used with care and discretion."

An interesting development in the handling of excavated material is the employment of the oil-engined dumper, in the evolution of which Messrs. E. Boydell and Co., Ltd., of Manchester have achieved well-merited reputation. The Muir-Hill 3 cubic yard dumper made by this firm incorporates many improvements resulting from their wide experience, and they claim to be the originators of the modern dumper. With its oversize pneumatic tyres and 27 h.p. petrol engine, this machine can negotiate soft ground and heavy gradients, being able to operate at high speed on comparatively rough roads.

The author has had practical experience of this type of dumper on heavy quarry work, which is about the most gruelling test to which any mechanical plant can be subjected. The employment of welded construction in the body gives tremendous strength with light weight, and a special reinforced body is available for heavy rock excavation which should be particularly attractive to the dock engineer.

LARGE DUMPER

In dock engineering there should also be ample scope for the employment of the larger type of dumper now available, and an interesting machine of this type has recently been introduced by Messrs. Aveling-Barford, Ltd., of Grantham, who build a large dumper with a capacity of 12 tons. The author recently visited the Grantham works, where he saw these machines under construction and carefully inspected all the details, which were impressive in their design and arrangement. This six-wheeled vehicle is powered by an oil engine of 128 brake horsepower, transmission being through a constant-mesh four-speed hydraulically controlled gear box. It is claimed to be able to plough through mud axle deep, with ample reserve power to climb any gradient on which the wheels will grip.

It can travel fast in either direction, an important design feature being the patented reversible driver's seat and controls. The front axle has a central pivot, the four driving wheels being mounted at the rear on oscillating side members, thereby permitting appreciable vertical movement; this articulation contributes towards smooth riding, enabling the vehicle to accommodate itself to uneven ground without distorting the chassis. Tipping action is operated through gear drive and roller arms, maximum angle of tip being 70 degrees in only 10 seconds.

The all-welded steel body is able to withstand the heavy shocks of loading, and it is interesting to note that the vehicle itself weighs more than 12 tons, nearly double the weight of a normal lorry of similar capacity. The oil engine is a Dorman six-cylinder high-speed unit, developing 128 brake horsepower at 1,500 r.p.m. The operating clutches are operated by hydraulic pressure of 250 lbs. per sq. in. derived from a three-cylinder plunger pump carried on the gear box. The driving wheels are mounted on rocker beams free to rock through an angle of 23 degrees to the horizontal; the overall length of the dumper is 24-ft. 3-in., the overall width 7-ft. 6-in., and the overall height 8-ft. 8-in. Weight fully laden is about 25 tons and the weight on the driving wheels under this load is about 20 tons. Forward speeds range from 3½ to 17 miles an hour and reverse speeds from 2¾ to 13¾ m.p.h.

EFFICIENT PLANT MAINTENANCE

The author is well aware that he has only touched upon a few of the many interesting aspects of excavating plant worthy of note. He is thoroughly convinced that efficient plant maintenance is the key to low operating costs, and that there are many facets of this subject which deserve careful study. For example, it has been argued that cable-operated bulldozers are more suitable than hydraulically-operated machines, but the fallacy here is that wire rope may not always be available, whereas on most public works contracts the fitter's shop can deal with repairs to hydraulic equipment. The great need at the present time is for some enterprising manufacturers to produce an unbreakable high-pressure flexible hydraulic hose, or at least some form of hydraulic pipe which can be moved through a considerable angle without breaking or without suffering unecessary wear. This is a matter in which the help of manufacturers of equipment for the petroleum industry could very well be enlisted.

Modern excavating equipment is an admirable example of the finest type of mechanical engineering, and yet can we say at present that the average driver of this equipment is adequately trained in its use? The author has seen large draglines handled with the skill of a master craftsman, and smaller machines with the rhythm of an artist, but he has also seen the deplorable results of employing ill-trained operators, who can easily ruin a good machine in a few weeks of careless driving. During the recent war training schools for excavator drivers were organised, and considerable experience was gained in methods of instruction, but for normal civilian work the establishment and running of such teaching centres would be uneconomic unless they were subsidised in some manner by a group of plant manfacturers; this is a matter which could be well considered by the Federation of Civil Engineering Plant Manufacturers. An alternative arrangement would be for a group of contractors to form a training establishment which would in a very short time pay a handsome dividend in the form of reduced maintenance and upkeep charges.

There is still ample scope for ingenuity in the development of excavating plant. For example, it has been suggested more than once that there is room for a dragline equipment which can be mounted on the rear end of a crawler tractor. It is possible that such a machine would be of great value on dock construction owing to its mobility on bad or soft ground.

HIGH-SPEED EARTH MOVING PLANT

In much dock and harbour construction there must be sites where the use of high-speed earth moving plant would prove economic. One of the most remarkable developments in this field has been the elevating grader evolved by the Euclid Road Machinery Company, which employs a very fast belt conveyor towed behind a caterpillar tractor, with a cutting edge at the boot which replaces the cutting edge of the scraper. Excavated material is loaded by the belt conveyor into a train of wagons alongside, and about 20 tons can be loaded in 33 seconds, a truly astonishing performance; it is indeed a stimulating spectacle to see one of these machines loading 20 tons of spoil at intervals varying from 30 to 45 seconds according to the nature of the soil. In the latest equipments, the dump wagons are fitted with bottom doors and can dump their load in eight seconds; the implications in the use of such machinery for taking out large excavations are obvious.

Finally, the author would put in a plea for the protection of plant drivers from the vagaries of our climate, believing that there is ample scope for the enterprising manufacturer to fit suitable cabs to bulldozers and other equipments, so that they can continue working even in heavy rain. No doubt this would be difficult in some cases, but it is noticeable that far more attention is paid to this matter in American plant than in the corresponding British equipment. However, it is encouraging to learn that British makers of this kind of plant are now fully alive to the need for such protection.

DECORATION FOR HARBOUR ENGINEER.

Our readers will be interested to learn that our contributor Mr. R. R. Minikin has been decorated Chevalier of the Legion Honneur for his work during the recent war in connection with the Mulberry Harbours. We extend our congratulations to him on this well merited honour.

Notes of the Month

EIRE HARBOUR IMPROVEMENTS.

As a number of the larger ports of Eire, notably Cork, Limerick, Waterford and Dundalk, have plans, either in operation or in preparation, for large-scale improvements, and several smaller harbours are in urgent need of dredging, the Eire Government is considering the purchase of modern dredging plant for a scheme of harbour development.

FLOATING DOCK FOR NANTES.

The Dutch tug *Thames* recently arrived at Nantes with a floating dock she had towed from Kiel. The dock, which is of 12,000 tons lifting power, will be managed by the Cie Nantaise de Reparations Navales, and has been delivered as part of the war reparations being received from Germany.

NEW WHARF STORE FOR WELLINGTON.

The Wellington Harbour Board has accepted a tender for the erection of a large new store on Aotea Quay, at an estimated cost of about £110,000. The store, which will be 596-ft. in length by 102-ft. wide, will have storage capacity of about 8,000 tons. It will be equipped internally with 10 electric overhead cranes and four electric wharf cranes will be installed on the breast work outside.

CASUAL LABOUR IN AUSTRALIAN PORTS.

A plan for the enlistment of casual labour to relieve shipping congestion in Australian ports has been announced by the Minister of Shipping, Senator McLeay. After inspecting conditions at several ports, he said that casual labourers would be used on the wharves only during an emergency, and would be in the category of seasonal workers. They could return to other employment during slack periods.

NEW PORT FOR YUGOSLAVIA.

It has been announced in the Yugoslav press that a new harbour is under construction at Ploce, to the west of the mouth of River Neretva, on the Adriatic Coast. A large area of marsh and rock is being levelled, and eventually, the port will be able to receive ocean-going vessels where previously small fishing vessels could approach only with difficulty. Over 400 metres of wharves have already been completed, and special wooden quays have been built for the needs of coastal vessels. Many new works have been completed which are essential for the development of the port, among them being a water supply system.

ROTTERDAM HARBOUR EXHIBITION.

An exhibition entitled "Rotterdam Ahoy" is being held from June 15th until August 15th, and is designed to present a picture of the progress made in reconstructing the city and its port in the five years since the liberation. The exhibition is largely concerned with the ports and its shipping and shipbuilding industries, but special sections are also devoted to the activities of salvage and dredging firms and to municipal welfare services. Also facilities have been provided to enable visitors to make motor launch tours of the whole of Rotterdam Harbour.

NEW DRY DOCK FOR SUNDERLAND.

Work has now started on the construction of a new dry dock for T. W. Greenwell & Co., Ltd., at the South Docks, Sunderland. The dock, which is to be 650-ft. in length, will be the largest built on the North-East coast for 46 years, and will occupy the site of the old No. 1 dry dock which was put out of commission by enemy bombing during the war. The contractors for the work are the Demolition and Construction Company, Ltd., of Westminster, and it is hoped that the dock will be in commission within two years. The gate for the dock will be constructed by Messrs. Vickers-Armstrongs of High Walker. It will be 85-ft. wide, and will be built at the foot of one of the slipways at High Walker Yard, and after special ballasting, will be launched into the Tyne and towed to the Wear. Delivery of the gate is expected in about 16 months time. When in commission the new dock will be chiefly engaged in the repair of tankers of up to 28,000 tons deadweight.

NEW PORT FOR THE DOMINICAN REPUBLIC.

A deep-sea port for the handling of the banana and sugar crop is to be built at the small harbour of Barahona under a contract worth about £800,000 recently awarded to a local construction firm. The work will include a breakwater and quays, with facilities for vessels of considerable draught.

RIVER DEEPENED AT TIENTSIN.

It was recently announced that the Huih River has been deepened between Taku Bar and Tientsin to enable vessels of 20-ft. draught to be accommodated at the Tientsin piers. Hitherto ships have been compelled to anchor at Taku Bar and transfer their cargo to lighters.

CONSTRUCTION STARTED ON NEW SOUTH WALES PORT.

It is reported that the first stage of the development of a deep see port at Iluka; at the entrance of the Clarence River, northern New South Wales, has been started, and construction work is now in hand. The cost of the breakwaters and other works will be about £A8,500,000.

FLOATING CRANE FOR OSLO.

A self-propelled floating crane which has been built by the Lübecker Maschinenban-Gesellschaft for the Oslo Port Authority, has now been delivered. The crane has a pontoon 35 metres in length and 16 metres in breadth, and has a lifting capacity of 100 tons, with a maximum lifting height of 35 metres above water. Two propellers give the craft a speed of from 3 to 4 knots.

DOCKS EXECUTIVE VISIT CUMBERLAND PORTS.

Members of the Docks and Inland Waterways Executive of the British Transport Commission visited the Ports of Whitehaven, Workington, and Maryport on the 21st June and following days, for the purpose of consulting with the harbour authorities and representatives of other interests concerned with the operation and use of the ports. The Executive were represented by Sir Reginald Hill (Chairman) and Mr. John Donovan.

KELVIN HUGHES MARINE RADAR.

A demonstration of the Kelvin Hughes Marine Radar, Type 2, was recently given in London. This version is a further development of the P.P.I. type radar equipment as used for navigational purposes, and while the new design includes many of the successful features of the earlier Type 1 and Type 1A equipments, recent advances in the technique of design and construction enable a simplified, more compact, and more efficient equipment to be produced. The principal features of the Type 2 design are the reduced dimensions and weights of the various units and the larger and improved display; the power consumption has also been reduced. Simplification of the equipment and a substantial reduction in the number of expendable items (particularly valves) contribute to increased reliability, while servicing is greatly simplified by new methods of construction.

FOR SALE.

SEVERAL UNUSED 6-TON STOTHERT & PITT ELECTRIC PORTAL CRANES, 63-ft. centre jibs, 60-ft. max. radius. Power travelling, 15-ft. rail gauge. 86 h.p. 460-480 v. D.C. motors driving 57 k.w. generator supplying 220 v. D.C. to crane motors. Generator mounted in special housing on portal frame. George Cohen Sons & Co., Ltd., Wood Lane, London, W.12. (Tel.: SHE 2070.)

SITUATION VACANT.

ASSISTANT CIVIL ENGINEERS required for positions on the staff of the Resident Engineer on a large Civil Engineering contract in the north-west of England. Applicants should have a good general knowledge of Civil Engineering work, including both construction and design. The work offers exceptional opportunity of gaining experience for young engineers and the probable duration of the contract will be three years. The salary will be between £450 and £650 per annum, according to qualifications and experience. Applications, giving full particulars and stating the earliest date on which the appointment can be taken up, should be addressed to: Box No. 115, "Dock & Harbour Authority," 19, Harcourt Street, London, W.1.

SUMMERSONS
Railway Siding
ENGINEERS

THOS. SUMMERSON AND SONS LTD. DARLINGTON

In terms of so much per ton freight handled—what does your railway siding cost to operate?

Taking into consideration all relevant expenditure; the amount by which the capital cost needs to be written down, the day to day costs of operation and maintenance, the related expenditure on repairs and replacement of rolling stock; what was the average cost of handling each ton of freight that passed through your sidings last year?

This cost per ton figure varies from siding to siding: but, comparing like with like, the figure is lowest when a siding is planned as an integral part of the works and stores layout, linked with the internal handling and transport system, and maintained in first-class condition.

What were *your* costs last year?

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